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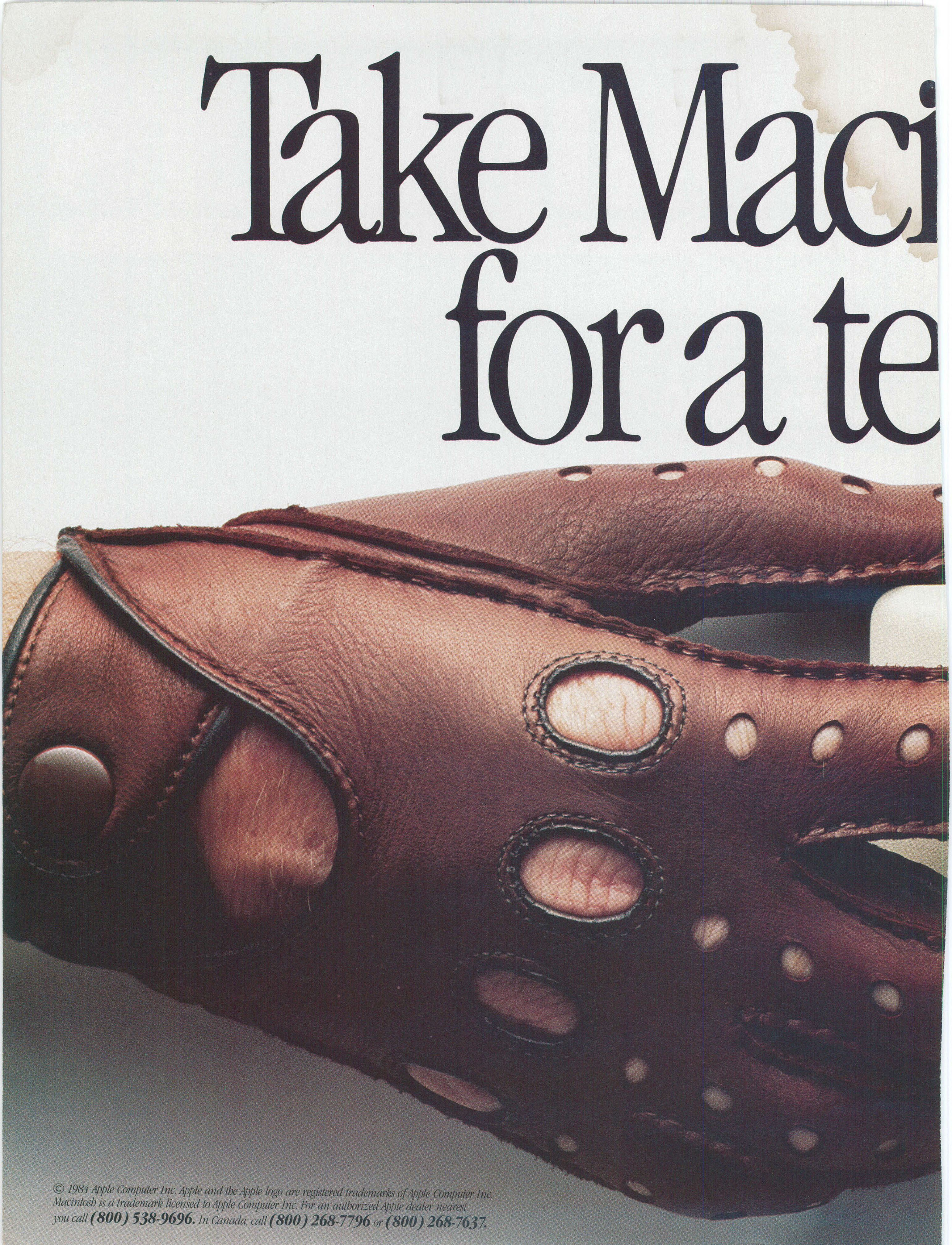

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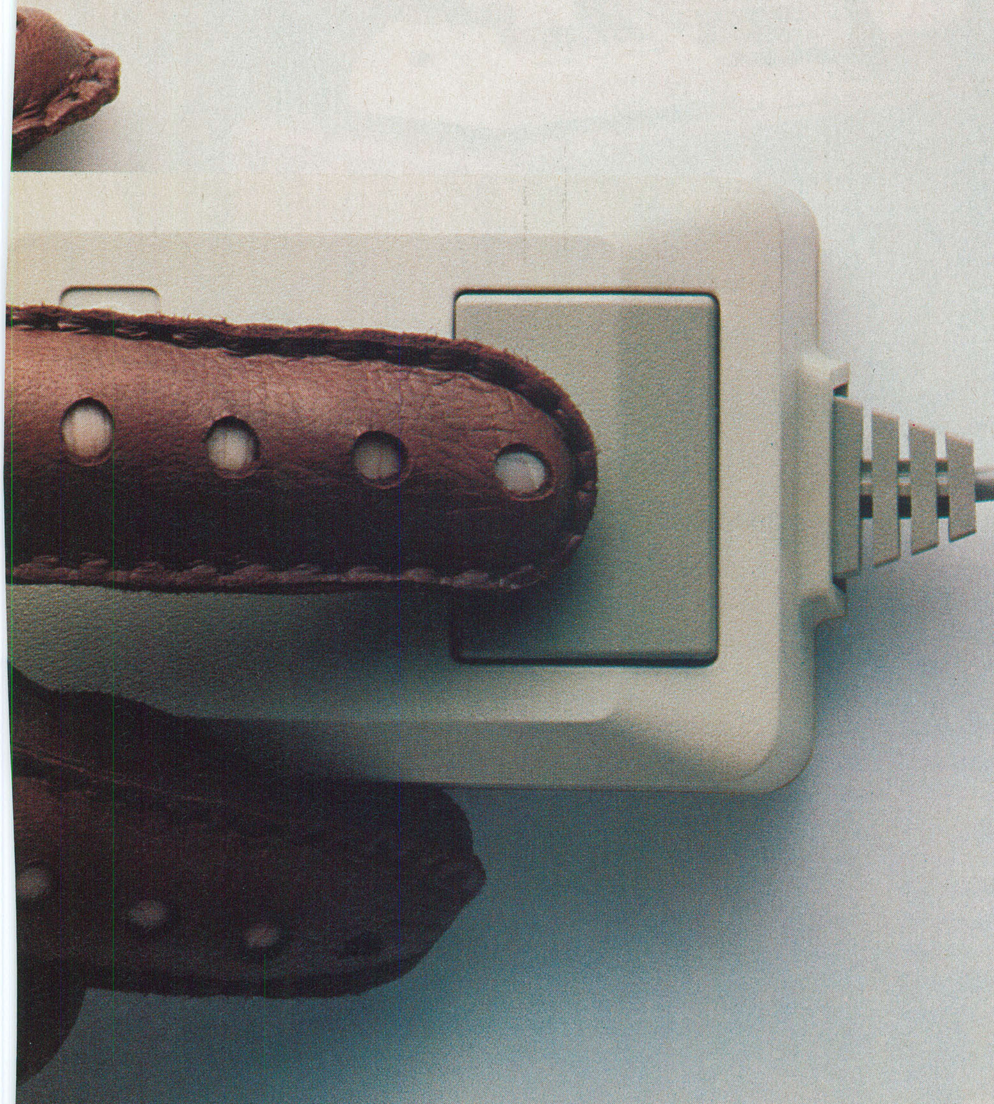

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VOLUME 22, NUMBER 12

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Features

Reviews

COVER BY TOM RYAN

Columns

Departments

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SETH R. ALPERT

EDITORIAL

PERSONAL ROBOTS

LET me begin with a confession. I am by nature a skeptic. Though fascinated by technology and all it has to offer, I am not someone who embraces a new product unless it offers fairly obvious benefits. Being editor of COMPUTERS & ELECTRONICS has not reduced my innate skepticism, what with the parade of ill-conceived and badly executed goods that we must wade through each month to find the things worth writing about.

Now, on the surface, this doubting attitude sounds quite healthy. It saves readers of C&E from being subjected to a lot of silly things that we might otherwise be gee-whizzing you about.

But we skeptics sometimes miss things. So it was with me. Back in the mid-seventies, when readers of POPULAR ELECTRONICS were discovering microcomputers, I was involved with timesharing, another form of rebellion against the data processing elite who controlled the world's precious computing resources. Those of us in timesharing had relatively free access to seemingly personal slices of mainframe computers and were able to get our work done more quickly and cheaply than our friends using batch processing.

Though the resources available to us were typically fewer than those available in traditional batch environments, they were considerable. The idea of switching to a microcomputer seemed at best uninteresting since the early micros had very limited memory and processing power and were also hard to use. As such, they did not seem to be an alternative for serious computing.

Of course, that viewpoint was not farsighted, and indeed the traditional timesharing industry has been rocked by the advent of powerful and inexpensive personal computers. Fortunately, I soon understood that something new and marvelous was happening and joined the micro revolution. But no, I cannot claim to have been one of the first or one of the early champions of a new cause.

I am telling you all this because today's personal robots, which John Conway discusses in a feature article in this issue, closely parallel the microcomputers of ten years ago. Few any longer doubt the importance of robots in the factory, and companies are making huge investments in this new technology so that they won't be left behind.

But personal robots? What can they do? Well, the answer, as you will learn in the article, is that, like the early micros, these early personal robots can't do all that much in the way of useful work—yet. Nevertheless, they are here, and people are buying and experimenting with them. Heath, for example, reports that over 8000 of its Hero robots have been sold. Before dismissing them as interesting toys, as I dismissed the early micros, we should take a serious look at personal robots because they may well be the harbingers of a new era.

It is an interesting comparison, isn't it, between today's fledgling personal robot industry and the fledgling personal computer industry of ten years ago. And it is particularly interesting to speculate about what the status of personal robots will be ten years hence. Will, as some have predicted, every family have a robot or two in the house by the end of the century? Or will it prove to be a field much like artificial intelligence (with which it is closely allied), in which progress comes much more slowly than any of the early innovators imagine? Some claim that progress will be rapid and benefit from bootstrapping, with robots eventually designing and building their more capable successors. Others claim that the problems the field faces are more intractable than proponents are willing to recognize.

Only time will tell. What do you think? ◇

PHOTO BY STEVE BORNS

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Editorial and Executive Offices
One Park Avenue, New York, N.Y. 10016.
212-503-3500

Advertising Sales Offices

Eastern

Ken Lipka, 1 Park Ave., New York, N.Y. 10016. 212-503-5029

Linda M. Holbrook, 160 State St., Boston, MA 02109. 617-367-7190

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LETTERS

Right On, On Touch Tablets

I woud like to commend Charles Rubenstein for his review of the Atari Touch Tablet and the Chalk Board PowerPad in the your September issue. Not only did he explain thoroughly how the products work and how to use them, he also said quite honestly that most people really wouldn't need them. I fully agree and I congratulate Mr. Rubenstein for saying so. I also congratulate you on your fantastic magazine.

—BEN PARRISH
Clarksville, MD

Behavioral Optometry

Amid all the sophisticated mumbo-jumbo about "behavioral optometry" (actually, "optometrical behaviourism" sounds more impressive, especially with the British spelling), saccades, ergonomics and assorted hooey, the most obvious difference between the way we normally perceive written language and the way it is displayed on a cathode ray tube was entirely overlooked ("Video Display Terminals and Vision," C&E, July, p 56). The difference is that normal print or graphics is black on a white or other light background, while most VDTs represent data as light on a black background.

After my first session with a VDT several years ago, I lost my ability to accommodate the image and couldn't focus closer than the standard distance to the screen. So nobody is going to tell *me* that these devices do not damage eyesight. I subsequently got a terminal with a reversing switch so that the signal is black on white (or color). I used this arrangement for an average of 60 hours per week with no further damage to my vision (or eyesight, if you prefer).

To say that "The problems are not caused by the VDT itself. Rather, the VDT simply exacerbates the user's existing problems." is equivalent to saying that asbestos doesn't cause cancer; it just exacerbates the predisposition to cancer that the person had all along.

—LAWRENCE E. COHEN
Coral Gables, FL

Bar Code Barrage

Your article on bar codes (April 84) contains a few inaccuracies that I would like to correct and some points on which I would like to expand.

A two-level code is one in which two element widths are defined: narrow and wide (an element is a bar or a space). Code 3-of-9 and the 2-of-5 family are two-level codes. Code 11 is three-level; UPC is four-level; and 2-of-7 and Codabar are 18-level. Codabar is actually a superset of 2-of-7 that includes some 3-of-7 characters, but the names are often used interchangeably.

The industrial bar codes (all but UPC) employ module width encoding in which a wide element represents a 1 and a nar-

row element is a 0. While many of the industrial codes are not two-level, they can often be treated as two-level by the decoding algorithms.

The commercial bar codes (UPC and its European superset, EAN) employ NRZ encoding, in which black represents 1 and white represents 0. The width of an element determines how many 1s or 0s. In UPC and EAN, each character is represented by four elements whose widths add up to seven modules (a module is the width of the narrowest element).

The commercial bar codes are not well-suited to industrial applications because of their limitations and their complexity. UPC and EAN are numeric-only and the labels are of fixed length. Their printing tolerances are considerably tighter than those for the industrial bar codes, and they are much more difficult to decode. Each character has three possible bar code representations (one odd-parity and two even-parity) whose use is determined by where in the label the character falls (left-hand or right-hand side) and what additional information is being encoded. UPC-E labels encode checksum information into the pattern of parities; they are not, as your article claims, less reliable for lack of a checksum. UPC-E labels are, in fact, UPC-A labels with enough 0s in the right places to be compressed into the "zero-suppressed" UPC-E form.

You are right in that several bar codes have been introduced. More than several; in fact, hundreds! Thanks to the Department of Defense, though, a very few are becoming standards. DOD's standard for alphanumeric bar code is 3-of-9, its standard for numeric is interleaved 2-of-5. The latter has the advantage of being the most compact numeric bar code around; the former is alphanumeric with an extended version defined that can represent the entire ASCII character set. I am not aware of any significant use of code 3-of-9 to represent computer programs, but the extended 3-of-9 would seem to be the most appropriate. The biggest problem here is compactness; extended 3-of-9 represents most of the ASCII set with two-character sequences, effectively using 20 bars and spaces (six of them wide) to represent a 7-bit character.

Bar codes have led a quirky existence over the years. As a means of disseminating program material they have been less than successful. (*Byte* magazine tried and then abandoned this method.) But they are becoming increasingly important in the areas of inventory control, material tracking and shipping, where they are making substantial improvements in productivity.

—NATHAN MEYERS
Hewlett-Packard
Portable Computer Division
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Whether the flaw is in a circuit board, a disk drive (often) or a printer (very often), *everybody* wants it fixed—and fixed fast.

It's little wonder that America's continuing love affair with the microcomputer has led to growing job opportunities. The U.S. Department of Labor recently projected that the number of computer service jobs will *double* before the year 1995. The same agency also reports median earnings of full-time computer service technicians are $430 per week (with much higher earnings for experienced service persons). And while all computer-related job opportunities are expanding, the computer service technician is the fastest growing job category of all (48% faster than electrical engineers, 92% faster than injection mold machine operators).

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LES SOLOMON ON

COMPUTER HARDWARE

SPRITES, MOONMEN AND FRACTALS

ONE of the earliest microcomputer games was Processor Technology's "Target," written for a VDM-1 plugged into the then-new Altair S-100 bus.

In this game, various types of "airplanes" flew across the top of the screen at various altitudes and rates. At the bottom of the screen was an "anti-aircraft" gun whose aiming angle and firing was determined by operating specific keys on the keyboard.

All the graphics used in Target were formed from nonalphanumeric characters (and combinations of characters) that Motorola used to fill out the many empty slots in early ROM alphanumeric character generators, particularly the one used in the VDM-1.

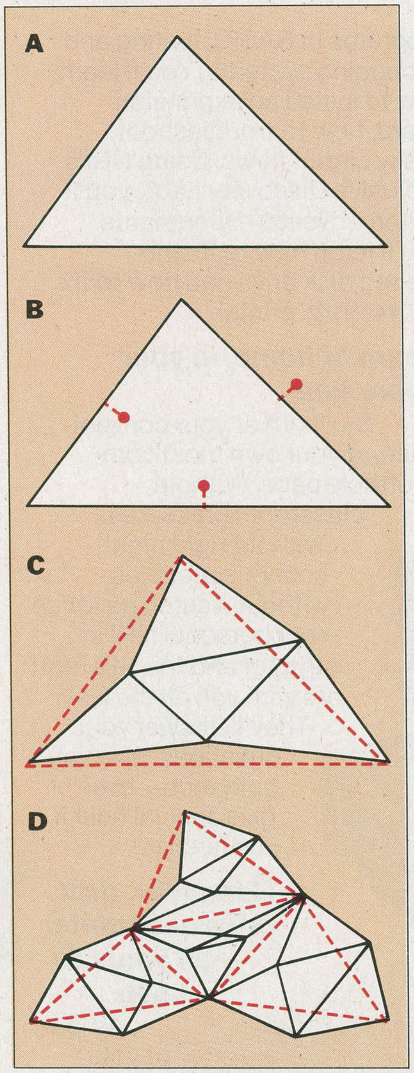
Among the strange-looking characters that could be put on screen was one cute little fellow we called "moonman" (a small hemisphere with tiny "legs" hanging down) because he looked like he came from there. Moonman was the hero of several very early computer graphic games.

The next step in computer graphics was "sprites." Like the nonalphanumeric symbols found in the older Motorola character-generator chips, sprites were also fully formed, with their configuration data stashed in the system memory. However, with more memory available, a sprite could be made far more elaborate than the 7 × 9 pixel ROM characters.

Also, a given microcomputer system could have a large number of different sprites stored in memory at one time, each to be "called" as required. Here were "busy" video games.

When improved color video monitors and TV receivers came along, sprites became high-quality colorful images. They also started to come in "sets" that allowed for on-screen animation when they were "called" in the right order (similar to the slightly changed images used in movie cartoons).

But computer graphics is not all games, and the search was on to create more lifelike images. New avenues of electronic research were explored to produce better video systems and CRTs, and better software was developed to run them.



Four steps in creating a mountain using fractals.

The major change occurred a couple of years ago, when well-financed movie studios entered the high-resolution graphics game. The movie studios, looking for new and cheaper ways to generate lifelike images, joined the many universities that were researching graphics software and created many new algorithms that could get the most out of the latest high-speed hardware.

The best examples of state-of-the-art graphics algorithms and systems can be seen in new science-fiction movies, like *Star Trek II* and *III,* the *Star Wars* sagas, and *The Last Starfighter.* In these movies it is difficult to see where live scenes end and computer simulations begin or even where the two are combined. The images you see are far beyond anything that the best and fastest microcomputer can generate. To create the images for just one movie, a Cray X-MP "supercomputer," which runs some 400 million mathematical computations a second, was used 24 hours a day for a few months.

Some computer-derived images reach 2048 × 2048 pixels and up to 24 bits per pixel deep. *The Last Starfighter,* for example, used 4000 × 6000 pixels per frame. Compare that to the "high-resolution" images generated on your microcomputer or even to conventional TV (about 512 × 512 pixels).

Obviously, these images result from many new hardware and software approaches to extremely high-resolution computer graphics. Although they are still a little too advanced for a typical microcomputer, hardware and software using some of these new techniques will be available for you to experiment with in the near future.

One of these new approaches is a graphics technique called "fractals." Following on work done by Benoit B. Mandelbrot of the IBM Thomas J. Watson Research Center, it is used to create high-resolution, realistic images. Fractal geometry is based on the fact that the closer you look at something, the coarser it appears. For example, you can create a distant mountain on a computer simply by using several lines of conventional high-resolution graphics. They might look good, but they won't appear to be very realistic.

As you look closer at a real mountain, what appears to be a simple element breaks up into smaller areas that in turn break up into even smaller areas that in turn break up into even smaller areas. Eventually, many of these break up into different strata, boulders, rocks, and possibly pebbles. Even smooth-looking rocks and pebbles get rough around the edges when you look close.

All of this detail (the fractals and the shading) is what makes a real mountain

(Continued on page 90)

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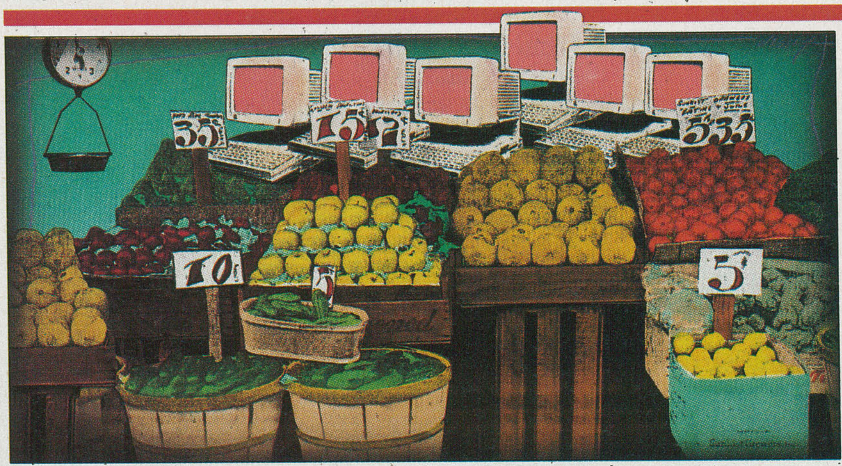


Apple Juice

▶ Sales of the Apple Macintosh appear to have leveled off due to a slacking of demand for personal computers generally and the distinct lack of applications software for the system. The result is that Macs are immediately available—with many dealers offering discounts or throwing in software or peripherals at no charge.

Key software, such as Lotus 1-2-3, has still not arrived in the retail channel. When the Mac was introduced last January, Apple promised that Lotus would be available "real soon," but availability has now been pushed back to the first quarter of next year.

Apple has announced price reductions for the Mac—to $2195. Also, the 512K Mac version originally expected next year was introduced this past September to stimulate sales. And there are rumors that Apple is actively engaged in developing a new version of the Mac and Lisa machines using the new Motorola 68020 microprocessor. This chip is a true 32-bit CPU capable of souping up the Mac's speed two to four times. Look for a possible January 1986 introduction, if not before.

On another front, Apple has filed its 28th court suit against a foreign maker of Apple II copies. This time it is Video Technology, Ltd., the first Hong Kong based company to be sued. Previously, Apple had gone after companies in Taiwan, Singapore, Australia, and New Zealand. Most of the copied components are made in Taiwan, shipped to Hong Kong for final assembly and then sold mainly in the Far East and Europe, with a few finding their ways to North America. Apple contends that 90% of all the Apples sold in the Far East are fakes.

Rumors & Gossip

▶ There are rumors that AT&T will announce this month two new low-cost systems being made for them by Convergent Technologies. Meanwhile, AT&T appears to be having delivery problems with its new 6300 Personal Computer. AT&T promised the units would be on dealers shelves by mid-July. But by mid-August dealers were complaining they had not yet seen their first shipments. . . . McGraw-Hill, which recently bought a software house, is now rumored getting set to acquire a microcomputer hardware manufacturer. . . . IBM is reportedly developing $5^1/_4''$ hard disk drives storing 30M and 50M bytes, at its Rochester, MN, facility. Speculation is they will be used in upgraded versions of the PC AT to be announced late next year.

IBM Rumblings

▶ IBM is expected to announce another round of PC and XT price cuts that may hurt the clones badly. Columbia and Eagle are already on the ropes and Televideo and ITT are also rumored not doing well with their compatibles. Price cuts possibly as great as 15 to 20% are anticipated, as these systems no longer will represent IBM's "leading edge" technology. Look for cut-throat competition in the 8088-based marketplace.

With the new IBM PC AT machine using the 80286, Intel has moved to ensure that there will be adequate quantities of the chip. They certainly do not want a repeat of the 80186 story: where OEMs had to wait as long as a year to receive production quantities. Intel is therefore assisting Advanced Micro Devices, Fujitsu in Japan, and Siemens in Europe to produce the chip family. We also hear that IBM is producing the chip set for its own use. Intel is predicting that, in 1986, over a million 80286s will be sold.

Clone manufacturers are expected to announce 80286 PC AT compatible machines. However, with supplies of the 80286 family predicted to be limited through the first half of next year, IBM appears to have a good 6- to 9-month lead on the clones. On the other hand, clone makers can be expected to offer significant improvements over the IBM machine—such as more users, more memory, more hard disk space, faster operation, and so on. The 80286 clone market battle should prove to be even more interesting than the 8088 battle. Compaq and ITT are expected to be first with AT compatibles.

IBM may also be negotiating with Hitachi to make a new lapsize PC. IBM has been privately showing a prototype lap machine using an 8086 and 80-character × 16-line display.

From Taiwan comes news that, at the request of IBM, the police raided two local computer companies who were making counterfeit PCs. Confiscated were copied machines and manuals bearing IBM's trademarks and logotypes.

Consumer Electronics Bus Standard

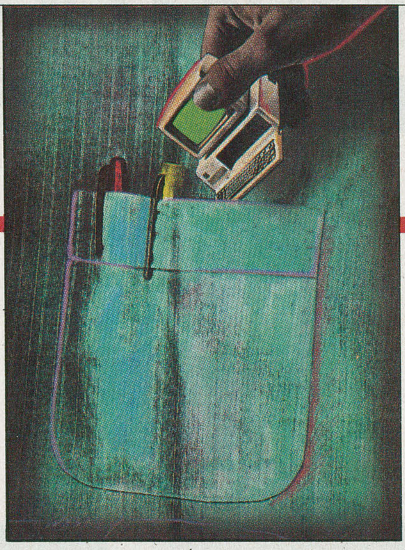
▶ As manufacturers start offering entertainment, communications, security and environmental electronic devices with computer interfaces for the home, there is renewed interest, on the part of the Electronic Industries Association (EIA), in the development of a standard for a Consumer Electronic Bus (CEB). The CEB standard would define the protocols used in communicating between a home personal computer and peripherals such as video tape recorders, TVs, and telephones.

A committee formed by the EIA two years ago is expected, in 1985, to issue a preliminary definition of the protocol for use with the power line. Standards are also being considered for infrared, rf remote control, twisted-wire pair, coaxial cable, and fiber optics. The protocol is expected to call for serial transmission of data with access to the bus via an arbitration scheme. It should be possible to transmit analog signals over the bus by digitizing it.

At a recent International Conference on Consumer Electronics, NEC de-

ILLUSTRATIONS BY CARL WESLEY

scribed a coaxial-cable system for the home capable of transmitting data, voice and video between 64 stations. At the same conference Nippon Telegraph and Telephone described a system in which the home telephone system was used to link electronic systems in the home.



Low Tide for Liquid Crystals

▶ When Apple introduced the IIc months ago, it promised an 80-character × 25-line LCD display for the unit by the fall to convert it to a portable. And HP, introducing its 100 portable in May, promised it would upgrade to a 25-line LCD before Apple. During the summer Apple even demonstrated a IIc with the new display.

Now comes word that Apple will not make the LCD available until next spring and HP is promising fall 1985 availability. In the meantime, at least one computer is already on the market with an 80 × 25 LCD. STM Electronics, Menlo Park, CA, started shipping its MS-DOS unit last June.

The problem appears to be twofold. First, the 80 × 25 LCD display costs about six times as much as a CRT display (the plasma and electroluminescents are even more) and the display does not look anywhere near as good. Second, the demand for portables with large displays does not appear to be great enough to provide the production quantities necessary to reduce production costs. In fact, sales of lap portables appear to be lagging generally, and many feel that the significantly higher prices of large-screen lap units will offset the advantage of the size of the screen. That appears to be why a company like Radio Shack has stuck with the Model 100 (40 × 8 display). Industry experts are now predicting that sales of the large-screen lap units will not take off until 1986.

Pocket Computer Launched

▶ Psion, London, England, has introduced what it claims is the world's first practical pocket computer. It uses plug-in EEPROMs (electrically erasable programmable read-only memories), which function as "disk" storage. The unit is $5^1/_2$" × 3" × 1" and weighs less than 8 oz. The (UK) price is about $140.

The unit can have two 16K EEPROM packs allowing the user to save and recall up to 32K of program and/or data. The unit has a builtin database manager and a 16-character display.

Atari Rumors

▶ Atari, now headed by Jack Tramiel, who created Commodore and made it the success it is, is expected to show prototypes of several new microcomputers at next month's Consumer Electronics Show in Las Vegas. Rumors are that Jack will be testing the market rather than showing units actually scheduled for production. Most likely only two will actually go into production and become available during the summer.

Expectations are that one will be an 8-bit machine that will compete with Commodore's home computer. The second is expected to be a 16-bit machine based on either the Motorola 68000 or Zilog Z8000. These latter machines are expected to have base list prices just under $1000 and will be intended for the IBM PC and Apple Macintosh markets. The probability is that both machines will be made outside this country. There are also rumors that Commodore is developing a 32-bit machine, but it probably won't be shown at CES.

In the meantime Tramiel has cut the price of the Atari 800XL to $159 (wholesale) to clear a large inventory, forcing a price war between it and the Commodore 64. There is little doubt that, if Jack is successful in moving the 800XL systems, Atari will resume making them.

AI Emerging from Labs

▶ Artificial intelligence, long the exclusive domain of university research laboratories, appears to be coming out into the commercial world. What amounts to the first wave of commercial AI products has been introduced by such companies as IBM, Xerox, DEC, Data General, Symbolics and Tektronix. At the recent gathering of the Association for Artificial Intelligence in Austin, several firms showed software tools for constructing knowledge-based systems.

At the conference IBM described six AI development projects that should shortly result in specific end-user products. First was YES/VMS, an "expert system" to operate a large computer system with significantly less human attention.

Next is the development of PRISM (Prototype Inference System) to allow developers to create a system shell based on their own rules and inferences. Then there is "Scratchpad II," which would allow scientist to manipulate algebra directly on a computer screen. IBM is also developing versions of the Lisp and Prolog languages for writing AI programs. Other IBM AI projects include machine language translation theorem proving and several AI development tools.

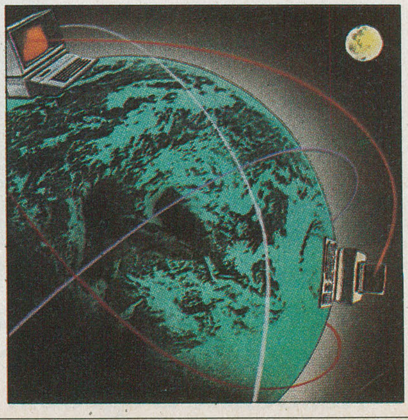
Amateur Packet Radio

▶ Four years ago, amateur radio operators began developing radio repeater stations for digital communications between amateurs using personal computers. There are now well over 1000 stations in operation.

Although most stations function only locally, a movement is under way to create a network of repeater stations that will allow amateurs to send and receive messages and programs from outside their areas. In July of last year amateurs in California created the first such network, call WESTNET, linking stations from as far south as San Diego to well north of San Francisco.

Further, AMSAT is expecting to launch a packet-radio satellite, for amateur use, in 1986. It will link personal computers around the world.

For more information on amateur Packet Radio, write to the nonprofit organization, Amateur Radio Research and Development Corp., PO Box 6148, McLean, VA 22106. ◇



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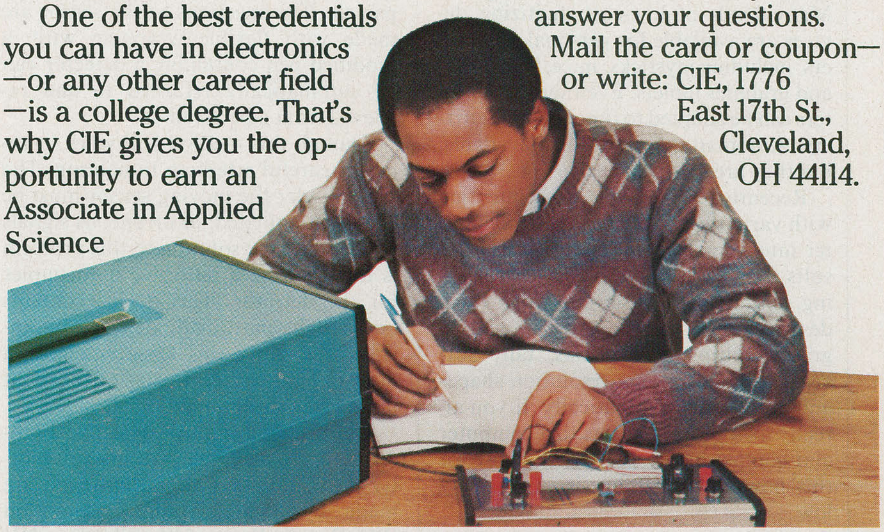

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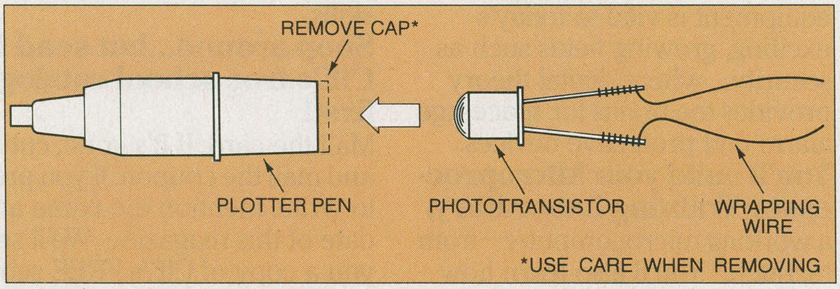


Fig. 1. How a light sensor can be installed in a plotter pen.

DIGITIZERS permit information ranging from simple data to complex shapes and patterns to be manually entered into a computer. Many kinds of low-cost digitizing devices are available for personal computers, including joysticks, mice, trackballs, and graphics tablets. Even some *xy* plotters can be adapted to function as digitizers. Automatic digitizers are available, but they are quite expensive.

Recently I've been experimenting with various ways to convert an *xy* plotter into an automatic digitizer. The results thus far have been very encouraging, and my present set-up, which I will describe here, can be programmed to grade multiple-choice tests, tally surveys, and digitize low-resolution shapes and images, all automatically. If you already own or have access to a computer and compatible *xy* plotter, the cost for this powerful capability is surprisingly low.

Optical Digitizing Methods

The automatic digitizing methods with which I've experimented are all based upon the optoelectronic (or photonic) sensing of the presence or absence of light or dark markings on ordinary paper. In operation, a computer is programmed to sweep the pen carriage of an *xy* plotter across a paper containing information or an image to be digitized. An optoelectronic sensor installed in the pen carriage is connnected to the computer's joystick port. A simple software routine permits the signal level from the sensor to be correlated with the precise location of its origin.

Although many different optical sensing methods are available, the simplest is to install a light-sensitive detector in a discarded plotter pen as shown in Fig. 1. The sensitive surface of the detector can then view the paper through the narrow aperture through which the ink once passed. If connections to the sensor are made with flexible wrapping wire, a modified pen containing a detector can be automatically returned to and retrieved from a pen stall.

Though this method will work, it requires careful attention to lighting. The paper under the moving sensor must be evenly illuminated, or erroneous signals will result. One solution to this problem is to substitute a reflective optocoupler for the detector. This device contains both a light emitting diode and a phototransistor. Since this sensor includes a built-in light source, it is not dependent upon external illumination.

Unfortunately, most reflective optocouplers are too large to fit inside a plotter pen. Some that might, however, are made by Skan-A-Matic Corporation (PO Box S, Route 5W, Elbridge, NY 13060).

Another sensing method that works quite well is to couple both the optical detector and a source of illumination to the plotter's pen carriage by means of fiber optics. This method permits very reliable, low-resolution digitizing with a minimum of external hardware. Indeed, when used with a PC*jr*, this method works exceptionally well with a readily variable cadmium sulfide photocell as a light detector. The photocell can be directly connected to one of the joystick ports on the PC*jr*.

The method can also be used with a Color Computer and certain other computers having joystick ports simply by adding a series resistor to the photocell and connecting the two components across 5 V. The resulting circuit provides an output voltage that varies in amplitude according to the light level on the photocell.

In short, it's possible to assemble an automatic optical digitizer from many different combinations of computers, plotters, and sensors. Following is a detailed description of one of the many possible arrangements. You may not happen to have the equipment I used, but with some planning you should be able to adapt the principles described to your particular system.

An Automatic Digitizer

The hardware necessary to transform an *xy* plotter connected to a PC*jr* into an automatic fiber optic digitizer is shown in Fig. 2. The sensor is a cadmium sulfide photoresistor having a low light resistance and a high dark resistance. A suitable choice is Radio Shack's Catalog

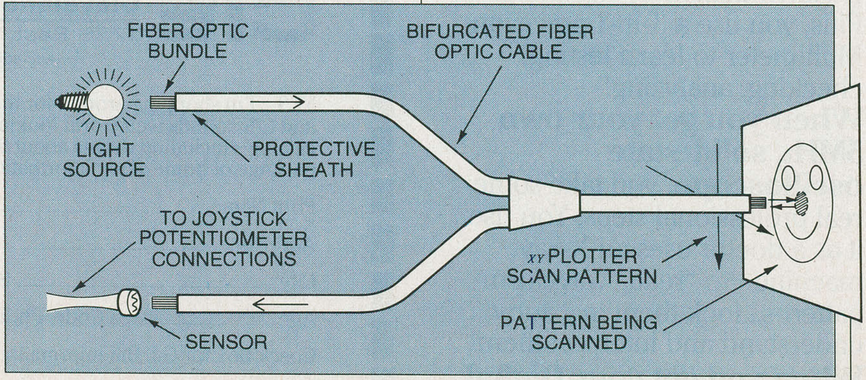


Fig. 2. Fiber optic automatic digitizer.

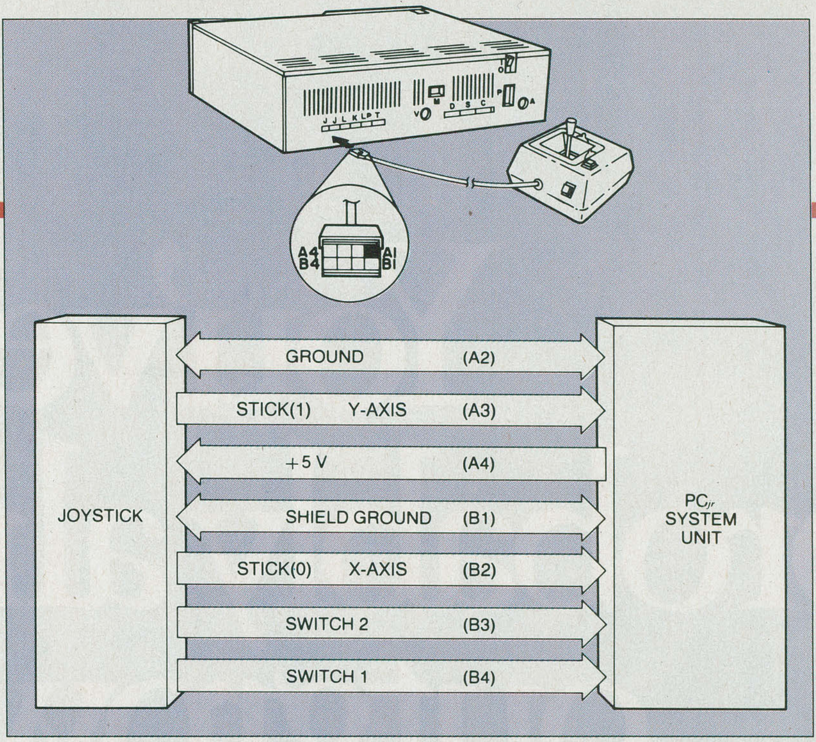


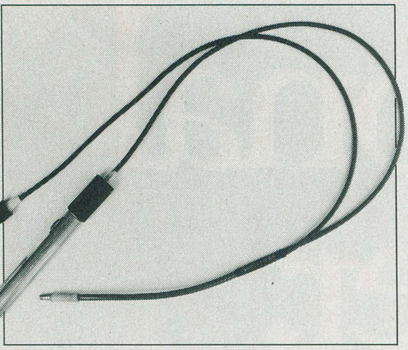
Fig. 5 PC*jr* joystick connections.

No. 276-116.

Since cadmium sulfide photocells have a relatively slow response time, illumination can be provided by either a battery or line-powered lamp. The photocell will ignore the 60-Hz intensity fluctuations from the line-powered lamp.

The fiber optic cable is the most important, and most expensive, component in the system. The *bifurcated* fiber optic cable used was formed from two cables merged into one in a Y configuration. The fibers in the two cables are randomly mixed in the stem of the Y.

Fig. 3. A bifurcated fiber optic cable with light sensor and penlight.



Light is injected into one branch of the Y where it evenly illuminates as pot directly below the end of the merged cables. Some of the light reflected from the paper enters the end of the merged fiber cable. Half this light travels up the side of the Y terminated by the photosensor.

If you've never worked with fiber optics, you may wonder how effective a bifurcated fiber optic cable is in this role. I found it to be exceptionally effective, and it is easy to observe the change in light intensity at the photosensor end of the cable when the sensing end of the Y cable passes over a black line drawn on white paper.

Bifurcated fiber optic cables are available from several companies, or you can make your own. The one I used is Dolan-Jenner's Type No. EE824. It is 24″ long and costs $60.00. Before ordering a cable, you may wish to request literature about the other bifurcated fiber optic cables made by the same company. Send your inquiry to Dolan-Jenner Industries, PO Box 1020, Woburn, MA 01801. Some of this company's cables have a smaller diameter and can be used to provide higher resolution. Keep in mind Dolan-Jenner has a $50 minimum order requirement.

Assembling the Digitizer

There are many ways to attach the photocell to the terminal at the end of one of the two branches of the bifurcated cable. One way is to insert the photocell into a length of heat-shrinkable tubing. Wrap the metal terminal on one end of the fiber optic cable with tape to increase its diameter and insert the wrapped end into an aluminum bushing previously inserted into the heat-shrinkable tubing.

The other end of the Y should be coupled to a light source. This can be done by inserting the end of the cable, wrapped with tape to increase its diameter, into a plastic or metal cylinder placed over the end of a small two-cell penlight. Another is to clip the free end of the cable to a small desk lamp with a small clamp or alligator clip.

Fig. 4. Internal circuitry of a PC*jr* joystick.

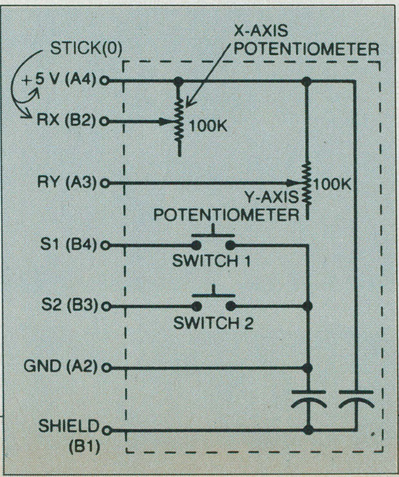


Figure 3 is a photograph of the bifurcated fiber optic cable used in my experiments. A flashlight and detector have been coupled to the ends of the Y, and the stem of the cable is ready to be inserted into the plotter's pen carriage.

The terminal at the end of the stem of the Y should be increased in diameter with tape or heat-shrinkable tubing and then *carefully* inserted into the top of the pen holder of a plotter. Although I used a Hewlett-Packard HP7470 plotter, others may also work.

After the fiber optic cable has been arranged, the photocell can be connected to the joystick port of a PC*jr*. Since it's difficult to find plugs that fit Junior's two joystick sockets, you may want to do as I have and modify a joystick by adding a small phone jack to it. Connect the terminals of the jack across the x-axis potentiometer. If the jack is the kind designed to switch a speaker off when a phone plug is inserted, use the switch mechanism to disconnect the potentiometer when a plug connected to the photocell is inserted. Insulated alligator clips soldered to a pair of wires connected to the plug can be clipped to the photocell's leads.

Alternatively, you can connect the

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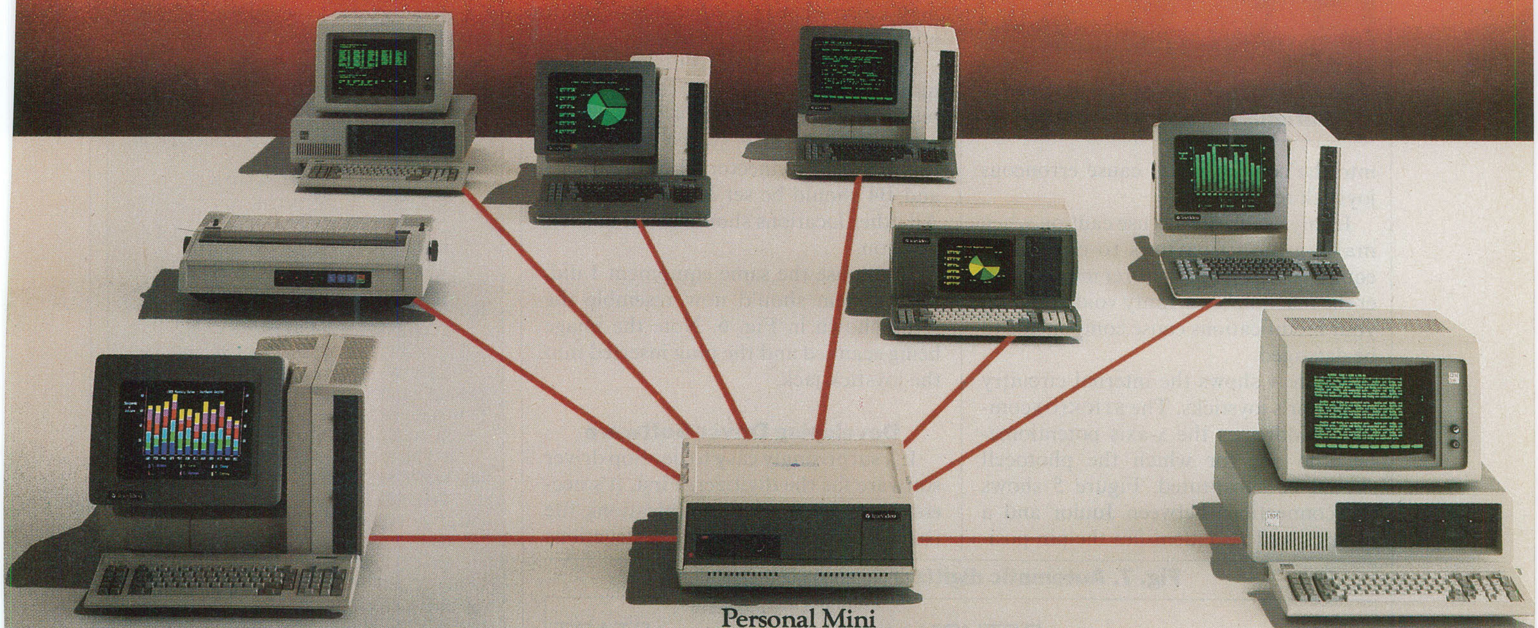

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photocell directly to Junior's joystick connector by using a hand-held wire-wrap tool. The wires can be removed later.

Unless they are shielded, the two wires connecting the photocell to the joystick jack or Junior's joystick socket should be relatively short. Otherwise, external electrical noise may be coupled

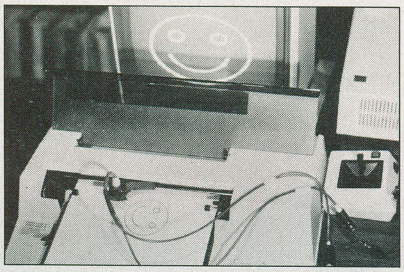


Fig. 6. Photograph of the author's automatic digitizer system.

into the computer and cause erroneous joystick readings.

In any event, always use caution when making modifications to computer equipment. A manufacturer may consider the machine's warranty voided should your modifications cause components to be damaged.

Figure 4 shows the internal circuitry of Junior's joysticks. The STICK(O) command addresses the x-axis potentiometer, the one for which the photocell should be substituted. Figure 5 shows the connections between Junior and a joystick and also identifies the pin posi-

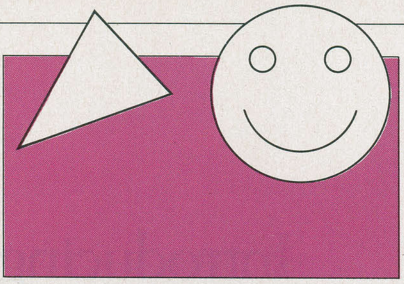


Fig. 8. Typical shapes scanned by automatic digitizer.

tions of the joystick's socket.

After the fiber optic sensing apparatus is completed, it's time to connect the plotter to the PC*jr*. The RS-232 version of the HP7470 should be connected to the serial ("S") port on the back of the Junior through a null modem connector. Depending upon the cable used, you may also need a female-to-female adapter.

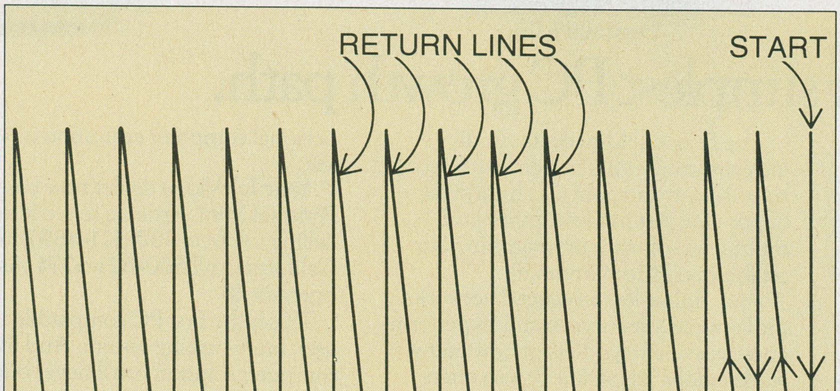
Next, it's necessary to make sure Junior and the plotter are on speaking terms. If you use the HP7470, check the settings on the DIP switch adjacent to the RS-232 connector. Locations US and B4 should be set at the *1* position. All other locations should be set at the *0* position.

If you use the same equipment I did, your system should now resemble the setup shown in Fig. 6. Note the image being scanned and the plug inserted into the joystick jack.

Developing Driver Software

It's surprisingly easy to develop driver software for the digitizer. First, it's necessary to open a communications file that permits Junior to send instructions

Fig. 7. Automatic digitizer scan pattern



to the plotter. If you use the HP7470, insert this line near the beginning of your programs: OPEN "COM1:2400,S,7,1,RS,CS65535,DS,CD" AS #1. For more information about modifying this plotter communications protocol, perhaps for use with other plotters, see Junior's documentation, especially the explanation of the OPEN "COM . . . " statement on

LISTING 1. AUTOMATIC DIGITIZER PROGRAM FOR PCjr AND HP7470 XY PLOTTER.

```
10 'AUTOMATIC OPTICAL DIGITIZER
   FOR
20 'PCjr AND HP7470 XY PLOTTER
30 'COPYRIGHT 1984 BY FORREST M.
   MIMS
40 KEY OFF:CLS:SCREEN 1,0:COLOR 1
50 SENSOR=STICK(0)
60 LOCATE
   15,15:PRINT"SENSOR="SENSOR
70 LOCATE 1,1:PRINT"CALIBRATION
   PROCEDURE;"
80 LOCATE 3,1:PRINT"ADJUST
   SYSTEM TO PROVIDE A
   DIFFERENCE OF"
90 LOCATE 4,1:PRINT"AT LEAST
   TWO UNITS WHEN PHOTOCELL
   VIEWS"
100 LOCATE 5,1:PRINT"A LIGHT AND
    DARK BACKGROUND."
110 LOCATE 7,1:PRINT"PRESS ANY
    KEY WHEN READY."
120 R$=INKEY$:IF R$=" "THEN 50
130 CLS:LOCATE 1,1:PRINT"NEXT,
    SUBTRACT 1 FROM THE HIGHER
    VALUE"
140 LOCATE 2,1:INPUT"AND ENTER
    THE DIFFERENCE: ",N
150 'PCjr-HP7470 PLOTTER PROTOCOL
160 OPEN"COM1:2400,S,7,1,RS,CS65535,
    DS,CD" AS #1
170 SCREEN 3
180 PRINT #1,"SC0,159,0,199;"
190 FOR X=0 TO 159 STEP 2
200 FOR Y=0 TO 199 STEP 2
210 PRINT #1,"PA"X,Y";"
220 SENSOR=STICK (0)
230 LOCATE
    1,1:PRINT"SENSOR="SENSOR
240 R=159-X
250 IF SENSOR>N THEN PSET (R,Y)
260 IF Y<2 THEN GOSUB 310
270 NEXT Y
280 NEXT X
290 LOCATE 1,1:PRINT"          "
300 GOTO 300
310 FOR A=1 TO 200:NEXT A
320 RETURN
```

pp. 4—240-246 of IBM's PC*jr* BASIC manual.

Next, it's necessary to develop a simple routine that scans the plotter's pen carriage across the paper being digitized. The HP7470 and other plotters can be easily scaled to match Junior's screen resolution. In the low-resolution mode (Screen 3), Junior's screen is divided into a grid consisting of 160 vertical and 200

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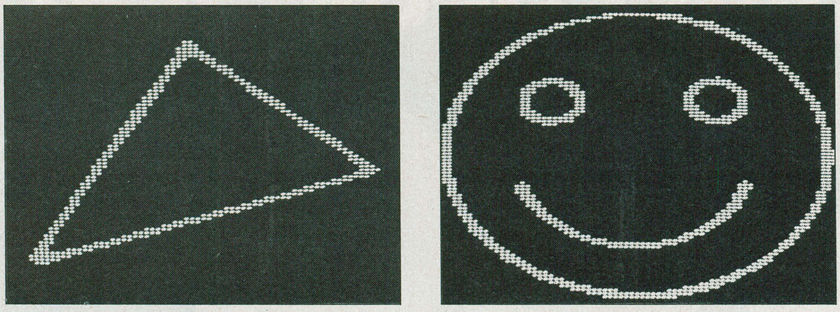


Fig. 9. Screen photographs of test shapes in Fig. 8.

horizontal boxes. This statement assigns the same scale to the HP7470: PRINT #1 "SC0,159,0,199;"

Now a simple BASIC routine can be developed to scan the pen carriage across the paper. The scan pattern can permit the fiber optic sensor to illuminate and examine each of 160 × 200 imaginary boxes on the paper being digitized. Or the program can be easily modified for faster operation by having the sensor skip any specified number of boxes.

Caution.

Never include pen selection or replacement instructions in your programs! To do so might damage the pen carriage mechanism. The only exception to this rule is if you use a detector housed in a pen and connected to the computer with flexible wires that do not interface with movements of the carriage or tangle with the pen stalls.

Listing 1 is a sample program that will help you understand how to develop driver software for your system. Here's how it works:

Line 50 assigns to a register labeled SENSOR the numerical value of the photocell reading [STICK(0)]. Lines 60-140 provide a calibration procedure that allows you to input a number that enables the computer to determine when the sensor is viewing a light or dark background. This number is determined by moving the pen carriage via the plotter's front panel controls across dark and light patterns on a paper while observing the readout window appearing on the monitor screen.

Lines 150-180 establish the communications protocol for the computer and the plotter. Lines 190-280 scan the pen carriage across the paper *and* paint a replica of the image being scanned on the computer's monitor. The scan resolution is determined by the Step values in lines 190 and 200. The values given in Listing 1 (2) can be changed to give higher or lower resolution.

The subroutine (lines 310-320) was added to provide a brief delay that prevents the pen carriage from making unwanted back and forth movements at the beginning of each scan. These movements sometimes cause false data to be plotted on the monitor screen. If you use a different plotter, you may wish to modify or eliminate this subroutine.

Finally, line 290 erases the readout window that provides the on-screen sensor readout when an image is being digitized. You may wish to omit this line and line 230 if the readout window blocks part of the image.

Fig. 10. Simple phototransistor sensor circuit.

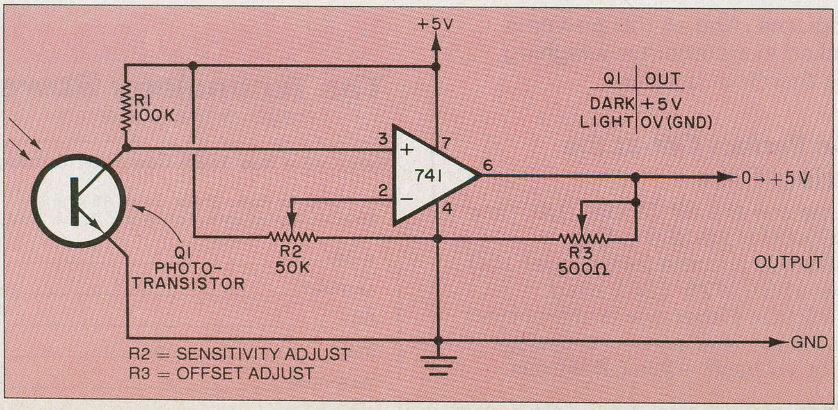


Figure 7 shows the scan pattern that results when the scan increment steps in lines 190 and 200 are increased to 10. You may wish to modify the scan pattern to provide bidirectional sensing. This will speed up the digitizing process.

Figure 8 shows two test shapes drawn with a black marker pen on ordinary typing bond and run through the automatic digitizer. The resultant screen images are shown in Fig. 9.

Note that the aspect ratio of the shapes has been altered. For example, the circular smile face appears as an oval in the screen photo in Fig. 9. This occurred because I manually altered the origins of the plotter (P1 and P2) so that the pen carriage scanned only a window containing the image and not the surrounding white space. Of course it's possible to preserve the proper aspect ratio by exercising the proper care when setting up the scanning window.

Incidentally, note that the triangle in Fig. 8 has no side parallel to the axes of the paper upon which it was drawn. I purposely avoided having a parallel side to eliminate any possibility of missing one of the triangle's sides during the scan. This can occur, as I found out the hard way, should a line parallel to the verticle axis fall halfway between two passes of the moving pen carriage.

Going Further

The basic techniques described thus far can be easily modified and expanded. For example, it's possible to devise relatively simple software that examines blacked-in answer boxes on a quiz sheet and tabulates test scores. By opening a second file, it's possible to store digitized images in Junior's RAM and on disk. Images can include maps, surveys, diagrams, graphics, charts, and possibly high-contrast photographs.

Though my digitizer experiments have thus far been limited to the PC*jr* and the HP7470, with suitable modifications many other combinations of computers and plotters should also work. The Color Computer should be particularly well suited.

You may also wish to explore other sensing methods. Figure 10, for example, is a straightforward phototransistor sensing circuit whose output has a potential of 5 V when the phototransistor is dark. Otherwise, the output is at ground (0 V). This kind of circuit can be easily adapted for computers that have voltage-dependent joystick ports.

For more information about light sensing circuitry, see *The Forrest Mims Circuit Scrapbook* (McGraw-Hill, 1983), pp. 43-45. ◇

READ ONLY

A review of the IBM Personal Computer Family. Vol. 1, No. 2

HARDWARE NEWS

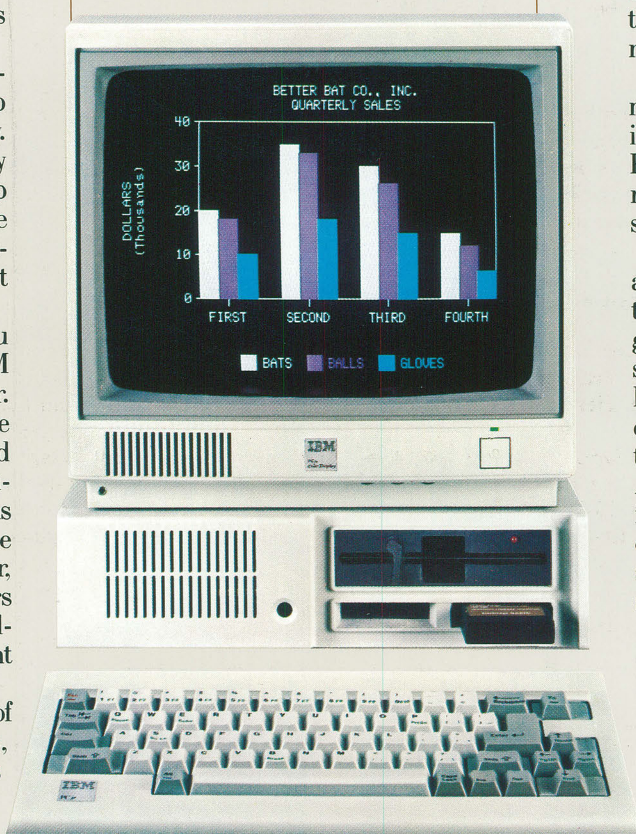
Progress. Even for a youngster with unusual potential, the IBM PC*jr* has made a lot of progress in its first year.

Consider memory for example. The IBM PC*jr* comes with up to 128KB of internal user memory. You can also add external memory expansion units of 128KB each, up to a total of 512KB. That's far more potential memory than other computers of its price range and weight class (10 pounds).*

Increased memory allows you to take full advantage of the IBM PC*jr*'s powerful 16-bit processor. With up to 512KB of available memory and PC*jr*'s double-sided diskette drive, you can run thousands of best-selling programs that have been developed for the IBM PC. If you're a programmer, the PC*jr* joins the other members of the IBM PC Family as a full-fledged application development tool.

There is also a variety of plug-in cartridge programs, which work faster than diskettes and don't take up any user memory. Three popular examples are Lotus 1-2-3™, PC*jr* ColorPaint, and Managing Your Money™ by financial expert Andrew Tobias. And every PC*jr* comes with cassette BASIC built into the system board.

PC*jr* makes it easy and affordable to start small and grow at your own pace. The $599 PC*jr* Entry Model, for example, comes with 64KB of memory, runs cartridge programs, and can easily be expanded into a diskette model. The PC*jr* Enhanced Model at $999** offers 128KB of memory—enough to run many programs from the IBM PC software library—and a 360KB diskette drive.



Cartridge-based programs for PCjr include Lotus 1-2-3™.

No matter which model you choose, the IBM PC*jr*'s 13 ports for plug-in options make it easy to add to your system, from more memory, to a modem, joysticks (PC*jr* can accommodate two), color monitor, or other peripherals.

Keys and colors. The IBM PC*jr* now comes with a new typewriter-style cordless keyboard that frees you to work up close or across the room from the system unit.

While PC*jr* can be connected to just about any display, including your TV set, the IBM PC*jr* Color Display offers some real advantages at a very reasonable price.

It has a built-in speaker and an earphone jack for educational and entertainment programs that feature music and sound effects. The non-glare RGB screen gives you better character definition and clarity than a color composite monitor. And since the PC*jr* Color Display is designed to be placed on top of the system unit, it's a space-saving addition to your PC*jr* system.

Whatever monitor you decide to add to your PC*jr* system, there's no extra expense for an additional interface card. Ports for both monitors and serial printers are built in.

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*Weight does not include power pack and monitor.

**Prices shown apply at IBM Product Centers.

Lotus 1-2-3 is a trademark of Lotus Development Corporation.

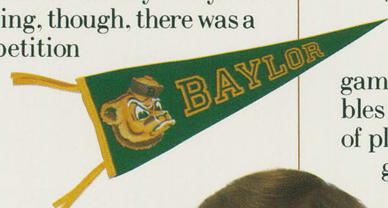
Managing Your Money is a trademark of MECA.

UP AND RUNNING

First String. It didn't take the IBM PC*jr* long to make the team. In its first year of eligibility, PC*jr* was picked by coach Grant Teaff to play a key position for the Baylor University football team.

Coach Teaff has a practiced eye for players with potential. He's coached the Baylor Bears to two Southwest Conference championships, been named Southwest Conference Coach of the Year five times, and was National Coach of the Year in 1975.

The Bears' coaching staff has used computers to help analyze scouting reports and playing patterns of opposing teams for nearly ten years. In the beginning, though, there was a lot of competition for a limited amount of computer time.



Coach Teaff and his assistant coaches had to write up all their game and player information and then have it keypunched. After that came a wait for processing time on Baylor University's mainframe computers, time that had to be shared with other departments and the university administration. Analysis of a game often wasn't available until a week after it had been played.

PC*jr* helped change all that.

Winning Tendencies. Coach Teaff calls the IBM PC*jr* "the ideal football coaching tool." With up to 512KB of available memory, it's powerful enough to make his staff independent of the University's central computers. And PC*jr* and the PC*jr* Color Display are inexpensive and compact enough to be used in offensive and defensive staff meeting rooms.

Using software developed by Coach Teaff, PC*jr* enables the Bears' coaches to enter information as they view game film of an opposing team and to see results immediately. When play-by-play statistics of several games are compiled and analyzed on PC*jr*, the coaches are able to identify tendencies of a team in given situations. They're then able to adjust their own game plan accordingly.

When Baylor plays new opponents, for instance, the two teams exchange films of past games. PC*jr* is used to analyze variables such as down, distance, and type of play. The Baylor coaches enter the game with much the same level of knowledge as if they'd played the new team for years.

The IBM PC*jr* helps out with other coaching duties as well. Team statistics, information about possible recruits, and numerous business and financial chores are all part of its workload.

Other coaches around the country had a chance to see the benefits of computerized coaching techniques this summer when members of the Baylor coaching staff demonstrated their programs at the nationwide football and basketball clinics sponsored by The Coaches, Inc.

Coach Teaff points out that a PC*jr* could make the difference between winning and losing to teams—small high schools, for example—with a limited budget and coaching staff. Using the PC*jr*, he says, "is like adding two or three men to the staff."

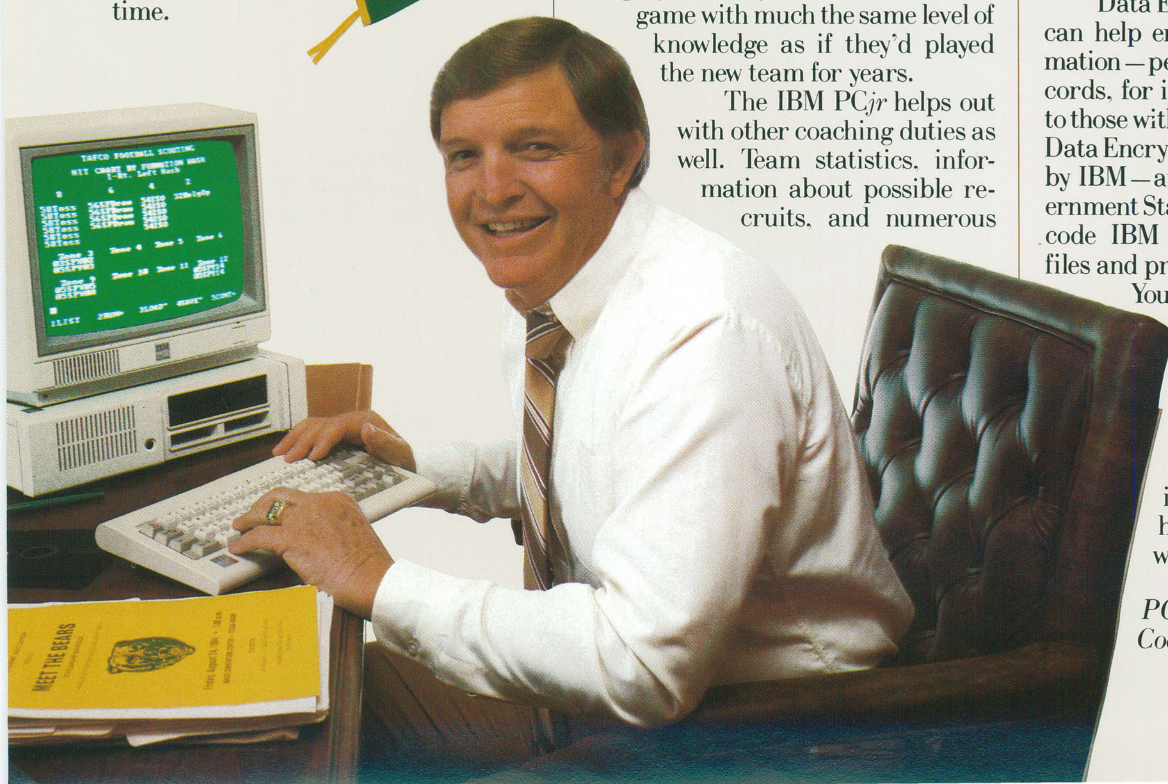
Not bad for a 10-pound, first-year player.

WHAT'S THE PROGRAM?

Maximum Security. Some information belongs under lock and key. But the rapid growth of personal computing and computer networks makes it increasingly difficult to keep it there.

Data Encoder software from IBM can help ensure that sensitive information—personnel and payroll records, for instance—is available only to those with a need to know. It uses the Data Encryption Algorithm developed by IBM—and adopted as a U.S. Government Standard—to encode and decode IBM Personal Computer data files and programs.

You don't have to be a master cryptographer to use Data Encoder. For members of the IBM Personal Computer Family with 192KB of memory, there's a full screen interface with menus and help screens. Systems with 128KB use easy



PCjr is a team player for Coach Grant Teaff.

DOS-like commands. You designate the key that triggers encoding and decoding procedures.

Files protected by Data Encoder can still be sent through IBM Personal Communications Manager or any other communications program with a text transparency feature. Without Data Encoder software and the proper security key, however, the information remains unintelligible.

So much for prying eyes.

In the clear. While some people are determined to keep things confidential, others want nothing less than perfect clarity. The following new members of IBM's growing family of programming productivity tools can help remove that unwanted element of mystery from your application programs.

The IBM Professional Debug Facility can help make short work of improving your assembler language programs. It includes a Resident Debug Tool for full function, full screen interactive debugging, a Disk Repair Program, and a Non-maskable Interrupt card for access to a system that's locked because of program error.

The IBM Personal Computer Application Display Management System (ADMS) simplifies creation of clear, informative screens for application programs. Since screen development is one of the most time-consuming programming tasks, ADMS can help dramatically increase your application development efficiency and productivity.

ADMS consists of two parts. The Application Display Designer is a screen building program that significantly reduces the program coding required for an application. The Application Display Manager is a run-time program that interprets the screen design code.

Screens defined with ADMS remain independent of the application program, so they can be modified or redefined without affecting the logic of the application.

The view from the top. It's worth noting that programs developed with the help of ADMS can run under TopView, IBM's new multitasking operating environment.

TopView's multitasking capabilities allow you to work quickly and efficiently with a wide range of application programs. You can switch rapidly from one program to another without reloading diskettes and can copy information from one application to another. Sales figures from a spreadsheet program and a document from a word processing program, for example, can be used concurrently to produce a sales report combining financial information and text.

In addition, the TopView operating environment supports advanced windowing facilities, data transfer among different applications, and pointing devices such as a mouse. All are features that enable you to work easily with a variety of applications.

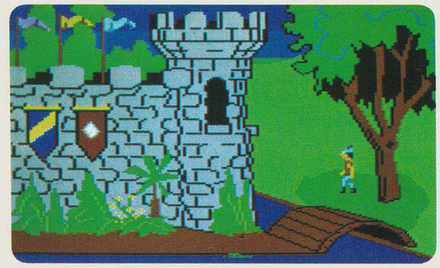
Data Encoder software from IBM.

There's also an IBM TopView Programmer's Toolkit available that contains the routines, utilities, and systems related information necessary to develop applications that run under TopView.

FUN AND GAMES

Medieval adventures. The ideal game is easier to define than to find: it should be entertaining *and* enlightening. There are new programs from IBM that manage wonderfully to be both.

King's Quest from IBM, for example, is chiefly for fun but does impart a few important lessons. The hero of this colorful three-dimensional adventure game, the valiant Sir Grahame, is sent by the King of Daventry to search the countryside for three magical items that will prevent the



King's Quest software from IBM.

kingdom's collapse. Along the way, he encounters dangerous creatures, makes new friends, and avoids—or tries to avoid—treacherous terrain.

King's Quest is unusually enjoyable because you interactively control Sir Grahame's wanderings, helping him duck, jump, or swim his way through the quest. Many tasks can be solved in different ways, and more creative solutions are awarded higher scores.

Hence also the educational value. Cleverness and imagination are rewarded. And a few valuable practical lessons are reinforced along the way. Looking, for instance, before one leaps into alligator-filled moats and deep, dark holes.

King's Quest runs on the IBM PC*jr* and makes good use of some special PC*jr* capabilities. Sir Grahame's movements, for example, are unusually smooth and realistic because multiple video buffers in main memory are used instead of a single chip to create the animation effects. PC*jr*'s three voice sound creates an impressive variety of sound effects, such as a fanfare of horns when the castle door opens. And PC*jr*'s ability to produce 16 colors lends a touch of realism to an imaginary kingdom.

Modern machines. But can a program with more serious didactic intent be as enticing as Sir Grahame's rough and tumble lessons? Yes, if it's Rocky's Boots™, winner of *Learning* magazine's Software of the Year award and of high praise from *The New York Times.*

In fact, Rocky's Boots from IBM is also a quest for creative solutions to a series of different games. Along the way, both children and adults can learn the basics of electronic circuitry and of the Boolean logic that drives computer operations.

Lest that sound too intimidating, remember that the learning is a by-product of games in which you build various simulated machines on your display screen. Early sections of Rocky's Boots guide you through basic instructions about building and activating simple electronic devices.

You're also introduced to the various "spare parts" and "tools"—such as clackers, boppers, alligators, and alligator detectors—that may come in handy. Later in the program there are more challenging games to play using the machines you've built.

All in all, Rocky's Boots is as thoroughly engrossing as King's Quest. And on one point, at least, it's easier. Sir Grahame has to make do without an alligator detector.

Christmas cheer. Rocky's Boots and King's Quest are part of a special Christmas collection of entertainment and educational software from IBM.

Some others in the Christmas collection come from the same series of IBM learning games as Rocky's Boots. They include Bumble Games™, Bumble Plot™, Gertrude's Puzzles™, Gertrude's Secrets™, and Juggles' Butterfly™. See your authorized IBM Personal Computer dealer, IBM Software dealer, or IBM Product Center for complete details.

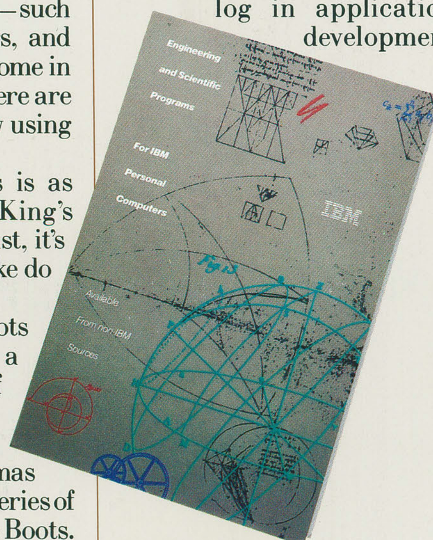
The Learning Company reserves all rights in the Juggles, Bumble, Gertrude, and Rocky characters and their names as a trademark and under copyright law.
Bumble Games, Bumble Plot, Gertrude's Puzzles, Gertrude's Secrets, Juggles' Butterfly, Rocky's Boots, and The Learning Company are trademarks of The Learning Company.

HARDCOPY

Full Disclosure. If business applications or entertainment programs aren't what you're after, there's a new software listing available from IBM, one with a long title but a specific purpose: the directory of *Engineering and Scientific Programs for IBM Personal Computers Available from Non-IBM Sources.**

It lists programs in a wide variety of engineering/scientific categories, from Computer Graphics to Lab Automation and Statistical Techniques. The *Engineering and Scientific* directory includes program descriptions, minimum configuration requirements, initial availability dates, and vendor information.

If your department or laboratory is suffering a backlog in application development work, one of these programs—in original form or with a little modification—may be the answer.



Directory of engineering and scientific programs for IBM Personal Computers.

For information about where to get the IBM *Engineering and Scientific* directory, see the box at the end of this issue of *Read Only.*

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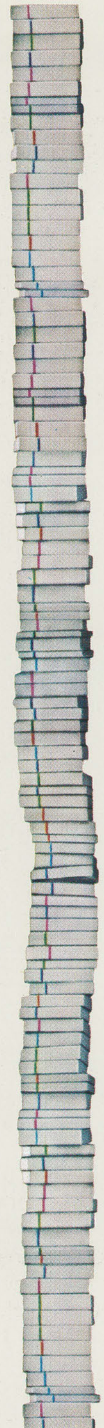
*IBM has not evaluated these programs and makes no comment, warranty, or guarantee as to their functions, quality, or performance.



TIPS AND TECHNIQUES

Living Dangerously. Diskettes lead dangerous lives. When they're not being folded, stapled, or otherwise rendered unfit for service, you might think they could at least spend a quiet evening in front of the TV set.

But no. Danger lurks there, too. All color TV sets and many color monitors have a degaussing coil around the face of the tube that demagnetizes the shadow mask inside the tube when the set is turned on.

If you keep your diskettes anywhere near (within a foot or so) the front of your color monitor or TV set, they may be exposed to a large shot of AC magnetic field every time you turn on the power. This could have a fatal and irreversible effect upon the data stored on the diskettes.

Don't degauss your diskettes.

IBM CREDIT CARD

The new IBM Credit Card gives you a convenient way to get started in personal computing or to add hardware and software to your IBM Personal Computer system. It's available with any purchase of $300 or more. You can apply for the card and make a purchase with it on the same day. See your IBM Product Center or participating authorized IBM Personal Computer dealer for details.

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For more information about IBM Personal Computer products discussed in this issue of *Read Only,* see your authorized IBM Personal Computer dealer or IBM Product Center. To learn where, call 800-447-4700. In Alaska and Hawaii, 800-447-0890.

HARDWARE REVIEWS

VIDEOSHOW 150

A breakthrough product produces slide-quality graphics on any RGB monitor

BY BARBARA E. AND JOHN F. MCMULLEN

GENERAL Parametric's VideoShow is a graphics presentation system that can take pedestrian charts and send them on a grand tour. With VideoShow's variety of background styles and fonts and its 1000 colors and 25 chart types, your presentations can acquire a cosmopolitan sheen. It is a unique and very powerful system, capable of displaying graphics of exceptional quality. At $3900, it is aimed at corporate buyers and must be used with an IBM PC or compatible and General Parametric's own PictureIt software.

How It Works

The concept is simple enough: You run PictureIt on an IBM PC to develop business graphs with appropriate titles and explanatory prose. The program stores the graphs on a standard IBM PC-DOS floppy disk. You place the disk into the VideoShow 150, which is connected to a color monitor (RGB or NTSC). With a remote control device, similar to those used to control television sets, you show the graphs.

Another impressive feature is the documentation. Neither overbearing nor incomplete, it is a well-written guide, complete with color and font charts, that will help users plan their presentations.

The system itself is relatively easy to use. The program on the PC (which requires 128K and two disk drives running under DOS 2.x) is menu driven and carries the user fairly easily from preparation to presentation. To illustrate the simplicity, we will go through the steps for developing a simple graph:

1. You activate the system (by turning the computer on with the PictureIt disk in drive A). A menu appears listing the various tasks that can be performed.

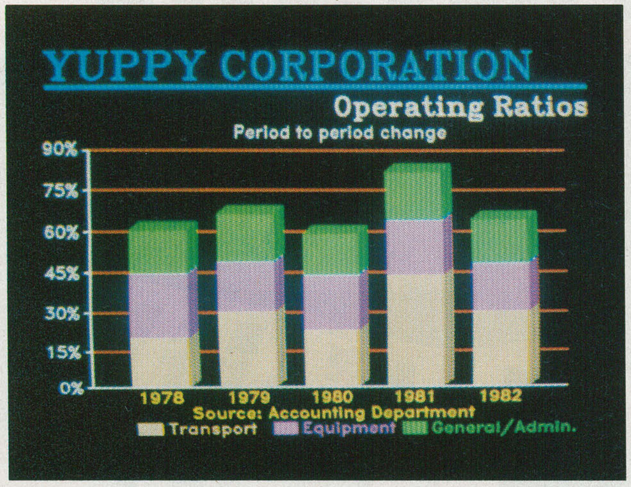
2. To create a new picture, you press F1. The system then asks for the format of the new picture. You choose from an available universe of 25 formats divided into four types: bar charts, graphs, pie charts, and word charts, with subtypes of each.

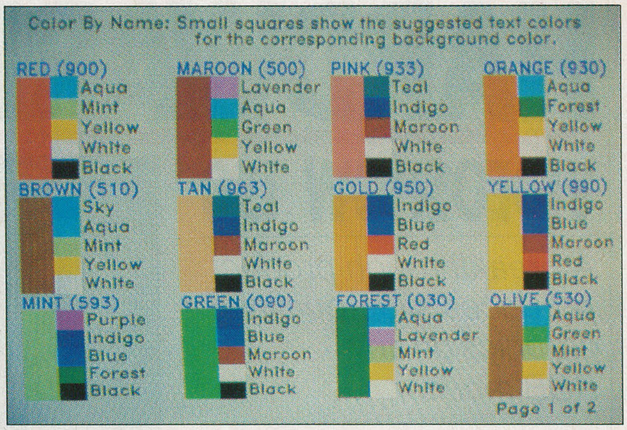
PHOTOS BY BOB LORENZ

3. The system responds by presenting a "short form" that is unique for the format selected. This form only requests information necessary for developing the picture. Otherwise, the system will utilize its default colors and styles.

4. You may choose to enter your own colors and styles by pressing the F4 key. The system's "long form" comes up. You fill it out by identifying the colors (by specifying any of 24 color names or any of 1000 three-digit color identifiers) you want. As mentioned earlier, the documentation provides samples of the long-form colors and styles for reference.

5. If your machine has a Graphics Controller Card, you can preview the picture on the PC monitor by pressing the F8 key. (The picture quality displayed on the PC monitor in no way approaches the quality of the picture that will be shown through VideoShow. You may put that quality online by connecting the serial port in the back of the VideoShow 150 to a serial interface on the PC. When you push the F8 key, the preview is displayed on a monitor con-





VideoShow display at left is a stacked bar chart. Above, PictureIt permits colors to be chosen by name and recommends certain combinations.

nected to the VideoShow 150.)

6. You can save the completed image to disk under the name assigned under Picture Name.

You repeat these six steps for each graphic display you desire. When you are running a series of displays on VideoShow you can make the display pause during the display formation. For example, you might display "actuals" (sales or expenses) for previous periods and then, after discussion, display on the same chart "estimates" for future periods. You can also overlay previous charts or highlight certain portions of the display.

7. When the generation of all the graphics is complete, you remove the disk on which the displays have been stored and insert it into the VideoShow 150 disk drive.

8. The first picture on the disk is displayed on the video device attached to the VideoShow 150. The display device may be a TTL, RGB, or NTSC monitor or a VCR unit, which would allow voice-overs.

9. You control the presentation either through a hand-held remote device or via the touchpad on top of the 150. (The remote control device gives maximum flexibility during the presentation.)

VideoShow's Components

The VideoShow 150 is, in fact, an 8086-based microcomputer containing 256K RAM and utilizing a proprietary process, trademarked under the name MacroVision, which replaces pixels with variable groups of dots as the target of system addressing. Franette Armstrong, General Parametrics' director of mar-

MACROVISION

BY SETH R. ALPERT

THE remarkable image quality the VideoShow 150 achieves on an ordinary RGB monitor results from a new approach to computer graphics that General Parametrics calls MacroVision. Obtaining an effective horizontal 2048 points on a standard color monitor is, indeed, a technical breakthrough. Accordingly, we interviewed Herb Baskin, the president of the firm, to learn how MacroVision works.

Baskin was willing to give hints, but with key patents pending, was not willing to describe the process in detail. It seems the screen is not managed pixel by pixel, as in other graphics systems, but in variably sized groups of dots. In fact, MacroVision can address each individual color dot on the screen to yield more colors and higher resolution than can normally be obtained with a given amount of memory and processing power. Also, MacroVision replaces the traditional technique known as anti-aliasing for reducing the jagged appearance of edges of objects. It uses instead a more powerful (and apparently very complex) method. Even MacroVision is constrained by existing monitor technology, so vertical resolution is the standard 484 lines.

These new techniques are based on algorithms designed to run on specialized hardware like the VideoShow 150. Not one to be unduly modest, Baskin makes the analogy that MacroVision is to computer graphics what Dolby is to tape recording and anticipates an equal degree of commercial recognition and success.

How good is MacroVision, really? Many of the images produced by the VideoShow are crisper than anything we've ever seen created on an IBM PC. However, the sharpness of the image seems sensitive to choice of foreground and background colors. Although the system can display 1000 colors simultaneously, for certain color combinations the text on charts was washed out and hard to read over the background. Other

Herb Baskin with VideoShow 150.

color combinations for the same chart yielded stunning images. General Parametrics, apparently recognizing these variations, includes in VideoShow documentation a guide to optimal color combinations.

Our impression, then, is that MacroVision does live up to many of Baskin's claims. It can produce screen graphics with greater resolution and more colors than anything previously available for standard color monitors. While it is not an exact equivalent of a color graphics system and monitor having 2048 $\times$ 484 resolution, it comes incredibly close at a fraction of the cost. ◇

keting communications, points out that this system produces much less picture distortion than any other process. (The system's horizontal positioning accuracy is $1/2048$ rather than $1/640$, which is the best to date of other systems.)

General Parametrics has priced the PictureIt software separately from the VideoShow device to encourage authors of graphics, communications and integrated systems to develop programs to support and interface with the VideoShow. Decision Resources recently announced a VideoShow interface for its Tell-A-Graf (a well-known mainframe graphics system that sells for about $30,000). We understand that other software manufacturers are developing interfaces to the system. Even while courting other systems developers, General Parametrics is preparing a second version of PictureIt that will include additional graphics formats and free-hand drawing of displays. Armstrong states that the firm is "committed to providing enhancements before the general user reaches the limitations of the current product."

General Parametrics' History

General Parametrics was founded in 1981 to provide graphics software by Herbert Baskin and Eugene Sanders, both thoroughly experienced in computer graphics (at Datapoint, University of California—Berkeley Computer Labs and IBM). In 1982, the firm began work on its first hardware device, the VideoShow 150, which they began shipping to Fortune 500 clients in November 1983. Based on what appears to be a successful start in that area and fortified with additional capital of $3,000,000 raised through Sevin-Rosen Management Corp., and Kleiner, Perkins, Causfield and Byers in February 1984, General Parametrics instituted a retail sales program in May 1984 and began to establish a dealer network.

Summary

We found that the system performs well the functions that we associate with quality presentations in corporate boardrooms. We realize that the price may seem prohibitive for individual users, but it is, in fact, quite reasonable when compared to the amount of money often spent to generate a slide video presentation in a corporate environment. In fact, the cost is low enough to open the door to presentation graphics for medium-size and small businesses and professionals. We feel that the system fills a niche previously empty, and we recommend you consider it. ◇

PRINCETON GRAPHIC SR12 & SCAN DOUBLER

Princeton's ultra-high-resolution color display system

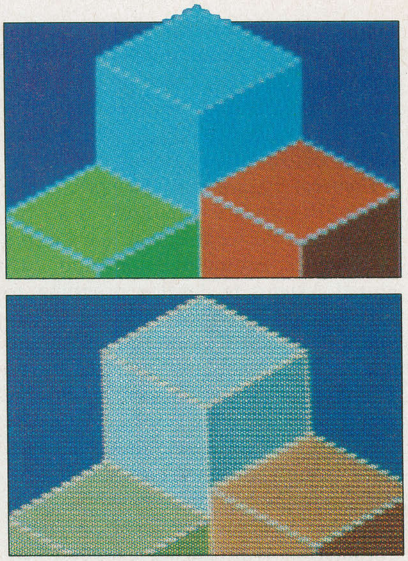
BY JOSEPH DESPOSITO

IT may be true that beauty is in the eye of the beholder, but for a monitor to look sharp, it must have high resolution. A new monitor from Princeton Graphic Systems, the SR-12, comes with a display capability of 690 × 480 dots in 16 colors. For use with the IBM PC and compatible microcomputers, the SR-12 works in conjunction with a plug-in board called the Scan Doubler, which produces twice the vertical resolution of an ordinary IBM color graphics board. Suggested retail cost of the SR-12 is $799; cost of the Scan Doubler is $249.

Setting up the SR-12

At least two plug-in boards (and two slots in the IBM PC) are needed when you use the SR-12 monitor. First is a color graphics board for the IBM PC. You can employ the board that IBM sells or any compatible color graphics board that uses the system clock. (Princeton Graphic publishes a list of boards that it has tested with the system.) Second is the Scan Doubler board, which increases the number of horizontal lines produced in the IBM PC high-resolution mode from 200 to 400. With these two you have the normal, but not the optimum, configuration.

The optimum configuration, the one we tested, adds one more circuit board to the system. This configuration uses the Quadcolor I color graphics board from the Quadram Corporation (Norcross, GA), the Scan Doubler, and the Quadcolor II, also from Quadram. Since the Quadcolor II is piggybacked onto the Quadcolor I, another IBM PC slot is not needed.



A close-up comparison of the SR-12 (top) and the IBM displays.

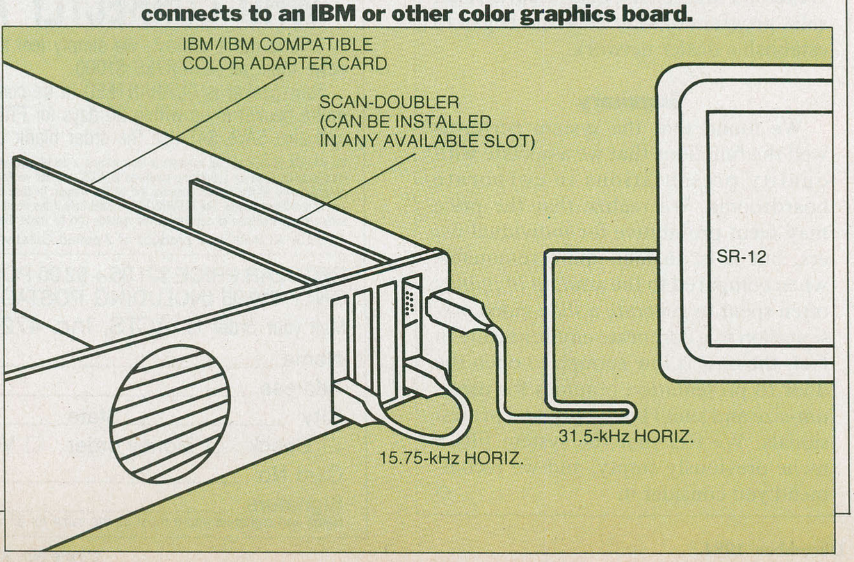
In any configuration, the system is hooked up as shown below. The RGB output from the color graphics board is fed into the Scan Doubler, whose output then goes to the SR-12.

The High-Resolution Display

What's the visual difference between 640 × 200 and 640 × 400 dots on a display? The main difference is texture. At 640 × 200, graphic images on the screen appear grainy. Also, the array of dots that make up a text character can be perceived by the user. At the higher resolution, images have a smooth texture and individual characters appear filled in.

(Continued on page 84)

The SR-12 receives its input from the Scan Doubler board that connects to an IBM or other color graphics board.



PHOTOS BY WALTER JACKSON

TAXAN TV TUNER

Your composite monitor can double as a high-quality TV

BY FRED BLECHMAN

A HIGH-QUALITY color TV for under $100 sounds too good to be true—and it isn't. But for $99.95 the new "My Tuner 305" from Taxan *will* allow your computer's color *monitor* to display an outstanding color TV picture. During the time you aren't actually using the monitor with your computer, it can function as a color TV set that's better than most others.

The Concept

A color transmission contains picture, sound, color and synchronization, all combined in a complex signal within a 6-MHz "channel." This signal appears, together with all other signals, at your antenna. It's the job of your television "tuner" to select the channel you specify from all the other signals.

A monitor is simply a TV set without a tuner, but with circuitry for a higher video bandpass and therefore a higher-resolution display. The video source—usually a video camera or video tape recorder—is connected to the monitor with a coaxial cable capable of carrying a high-bandwidth signal. Because of the more direct connection and signal conversion, a monitor picture is inherently more stable and less troubled by interference than a TV set. Also, because of the higher internal bandwidth within the monitor, a much better picture is produced.

As inexpensive microcomputers developed the ability to produce graphics of higher and higher resolution, users chose monitors over televisions for their display. (Many computers have a "composite video" output, and a coaxial cable connects the computer with a monochrome or color monitor.) Because monitors are designed to much higher bandwidth specifications than televisions (20 MHz is not uncommon) and far more attention is paid to vertical and horizontal size and linearity, extremely good pictures result.

Thus, there are literally millions of monitors in use with the capability of receiving standard TV shows—if they only had tuners.

My Tuner 305

Taxan recognized this marketplace void and has just introduced a high-quality tuner to be used with a "composite monitor" (not the RGB type). The monitor should be capable of accepting a standard NTSC signal (most are), and can be either color or black-and-white. (Actually, a green or amber monitor could be used, but the TV picture would be all green or amber.)

This small $6^1/_4$"W × 8"D × $3^1/_4$"H), beige unit comes with two cables and a power cord. On the back of the unit are five jacks. The antenna input is a F-61 jack commonly used with an F-59 plug on a 75-ohm television cable. Two input jacks and two output jacks each use an RCA phone jack for video and a miniature phone jack for audio.

The attractive blue and black sloping front of the tuner has white markings for all standard TV channels in three bands—lo vhf (2-6), hi vhf (7-13), and uhf (14-83). The channel selector is a sliding bar (no detents) that moves across from left to right. A front power switch lights a LED when power is on, a slide switch selects the band (lo/hi/uhf), and another slide switch lets you select tuner or computer.

The Tuner Connection

If you have a computer with NTSC video output, you simply plug the video cable that normally goes to the monitor into the tuner video input. If your computer has a separate audio output cable, it plugs into the tuner audio input jack.

With the cables supplied with the tuner, you can connect the tuner output jacks to your monitor's inputs. That's all there is to it.

You may, however, have a problem mating connectors. For example, you may have an antenna that uses 300-ohm twin-lead wire that cannot be directly connected to the Taxan F-61 antenna jack. No adapters are provided or even mentioned in the tuner's simple documentation. Fortunately, you can get all kinds of inexpensive plug adapters at local electronics stores, like Radio Shack.

Also, the tuner does not come with its own whip or rabbit-ears antenna. No doubt the 75-ohm antenna connector was intended to force you to provide a decent antenna so that you'd have a good picture with the least external interference. I would prefer to have the convenience option, however, of a built-in whip or external rabbit ears.

Another problem you may run into concerns sound. Though your monitor may have a composite video input, it

(Continued on page 90)

Input and output jacks and antenna input are on the back.

PHOTOS BY WALTER JACKSON

"HOW I MADE $15,000 FOR COLLEGE BY WORKING WEEKENDS."

When my friends and I graduated from high school, we all took part-time jobs to pay for college.

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SOFTWARE REVIEWS

CAD PLAN

Professional-quality computer-aided design system

BY ROBIN WEBSTER

Unlike a writer, who can misspell or mistype words and then correct the manuscript with a few simple keystrokes on a word processor, when a draftsman makes a mistake, he must start a drawing all over again.

But now computer-aided design (CAD) systems are liberating the draftsman from thou-shalt-not-make-an error tyranny. CAD also offers speed and an array of new tools. You can draw a blueprint of a high-rise office building, for example, and later rearrange the floor plan or wiring diagrams by moving lines and objects around. With such a system, engineering designs can be cloned and tinkered with whenever the need arises. Now, with the Personal CAD Systems' Cadplan, some of the power of big CAD systems is within reach of personal computer users, hobbyists and designers.

The Cadplan system is a graphics package that can be used to draw, edit and print two-dimensional designs. In addition to its drawing facilities, Cadplan features a "database extraction," which can be used to keep track of how many times a particular item is used in a design, its total cost, and the vendor's name.

Cadplan's Structure

Cadplan operates on an IBM PC and requires 320K of RAM, two 320K floppy disk drives, a color/graphics adapter board, and at least one serial port for an input device such as a mouse or a digitizer pad/tablet. If you use an IBM system with more RAM or an attached hard disk, Cadplan will operate significantly faster. (Cadplan cannot be used in conjunction with RAM disk systems or DOS 2.0 spooling/buffering. Also, the main Cadplan disk uses a copy protection scheme so you cannot make backup copies unless you connect a "security device," which is supplied.

I used Cadplan on a 320K IBM PC with two floppy drives, although I did manage to check its performance on an XT. I had a three-button optical mouse (Mouse Systems M2) for the input device.

After booting Cadplan, the user is presented with an initial screen that lists the types of input and output devices supported by the product. At the bottom of the screen is a one-line message that confirms the amount of RAM memory installed and indicates the number of "database layers" supported. A 320K system can support up to 10 layers, and a 640K system can support up to 63 layers.

The database layer is a key Cadplan concept. If you're drawing the wall of a house and want to show how the electrical wiring and the plumbing should be routed, you draw the wall on Layer 1 (where all lines are solid and green), the wiring on Layer 2 (solid red lines), and the plumbing on Layer 3 (solid yellow lines).

The user "descends" or "ascends" through these transparent database layers via a main menu option called LAYer. As I said, the number of layers you can use is related to the amount of RAM memory you have.

The user moves around the surface of each database layer (in the H and Y directions) by moving the mouse-controlled cursor, by entering specific coordinates through the keyboard, or with the PAN command, which I'll describe later. Current cursor coordinates constantly appear along the bottom of the display.

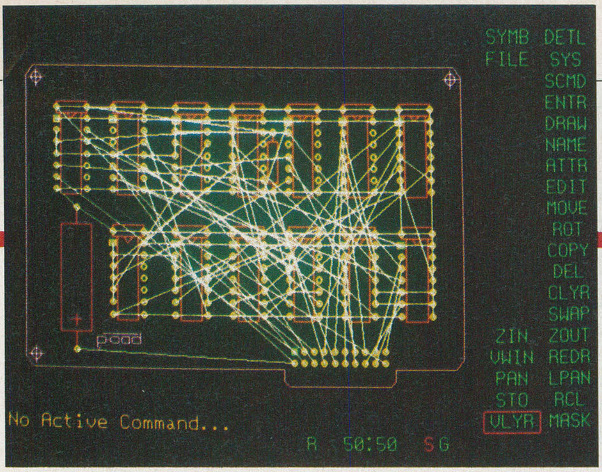
The virtual layers provide 60,000 coordinate points (from top to bottom and from side to side), but the exact drawing dimensions available will depend on the measuring scale that you preselect—a foot and inch scale allows 60,000" in either direction; a millimeter scale permits about 60"; and a special units scale simply allows 60,000 user-definable points.

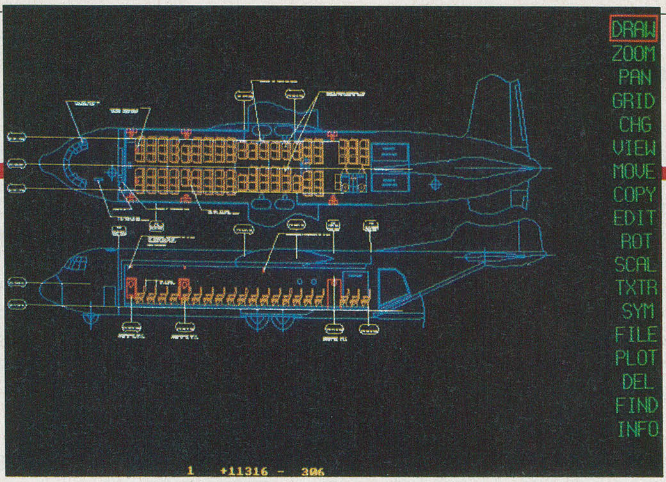
Once you have chosen the scale you wish to work with, objects will only be accurate to the minimum unit of mea-

PHOTO BY STEVE BORNS

Specifications

Product: Cadplan
Mfr: Personal CAD Systems, Inc.
981 University Ave.
Los Gatos, CA 95030
Price: $1300-$1900
Operating System: IBM PC-DOS
Requirements: IBM PC with 320K RAM; two 320K floppy drives; color/graphics adapter board; mouse/digitizer or other supported input device





Mouse-driven menu is on the right side of screen. Drawings can be layered to show components.

surement (1″ in the case of feet and inches or 1 mm in the case of millimeters). Make sure you know the dimensions of the smallest object you intend to draw before selecting a scale—Cadplan will not allow you to include anything measuring less than your minimum scale setting. Also, you will not be able to position lines or objects as close together as you might wish.

To begin work, the user must select one of 18 main menu commands, which are arranged vertically along the right-hand edge of the display. When the crosshair (+) cursor is placed over the menu options, the cursor changes into a red box-shaped outline that can only fit over one command at a time.

Commands are invoked by placing the cursor over them and then pressing the left-most button on the mouse (button 1). In many cases, main menu commands have submenus from which more specific actions can be selected.

A good example of this submenu approach is the DRAW command at the top right of the display. By selecting DRAW, the user is presented with options that allow lines, shapes, and text to be drawn. The STRAight line option is used to create horizontal or vertical lines, or those at a 45 degree angle. The ANGLe option, on the other hand, allows straight lines to be drawn in any direction.

To draw a line, you place the cursor at the starting point, press button 1, then move the cursor to where the line should end. As you move it, the cursor is linked to the beginning by a shimmering dotted line. You tell Cadplan that you want to confirm the line by pressing button 1 again. The shimmering line then becomes solid.

Although you have now drawn a solid line, the dotted ghost line continues to follow the cursor wherever you move it. This is useful if you want to draw a rectangle very quickly since you don't have to define each of the four sides as separate lines. Give Cadplan the four corner points, or vertices, and it will join them.

To unlock the cursor from the ghost line and move on to another part of the drawing, you press the second mouse button (button 2). If you make an error in placing a vertex, you simply press button 2 and the current unconfirmed line disappears.

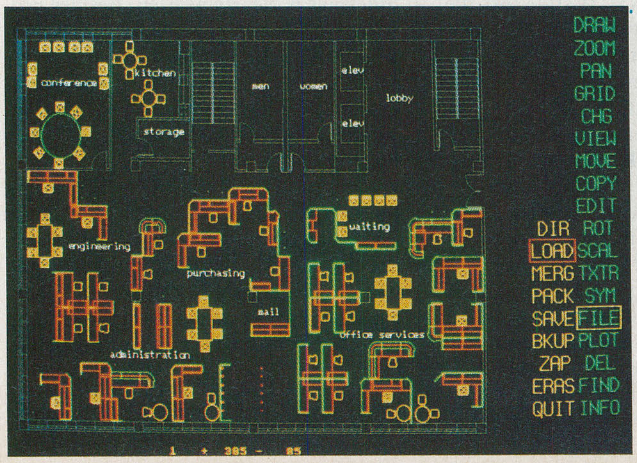
This point-to-point digitizing method is used to draw lines, circles, rectangles and arcs. You can place these objects anywhere on the drawing surface or, if you need to maintain a certain accuracy, you can tell Cadplan to lock all vertices to the nearest point on a range of special grids that can be turned on and off.

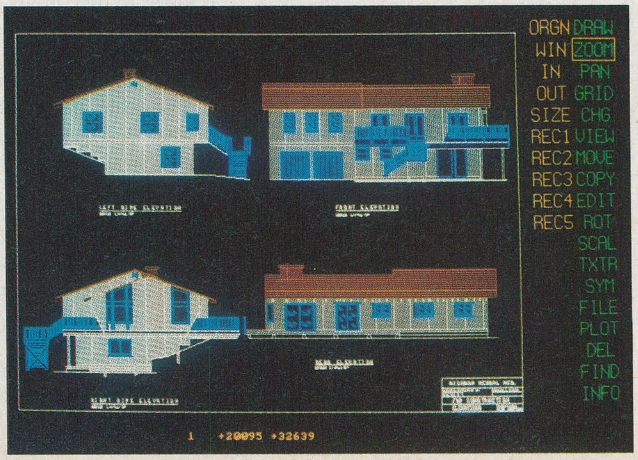
For situations where a circle or an arc must be carefully positioned between objects, the Cadplan system provides what is called *three-point digitizing*. The three-point method is enabled by selecting CIRCle or ARCS from the DRAW submenu and then pressing the number 3 on the keyboard. Given three points (three mouse-selected positions) to work with, Cadplan will generate the circle or arc that fits best.

Other than the geometric options, the DRAW command offers: TEXT, to produce text labels of different sizes that can be arranged horizontally or vertically and left/center/right justified; WIDE, which is used to change the thickness of lines; and DIMension, which is used to calculate and display the dimensions of an object.

If you're familiar with the LisaDraw package on the Apple Lisa computer, you'll have a good idea how Cadplan's auto DIMension feature works. LisaDraw gives real-time feedback for the size of a rectangle, circle, or line that the user is drawing; as the image is stretched

Plans can use symbols to represent repeated objects. Once created, they can be saved and reused.





Cadplan

or compressed, the measurements are constantly updated.

With Cadplan the DIMension feature is not really a real-time readout, but the measurements, once taken, can be permanently displayed. First you draw an object and verify its size with a command called DIST. Next you select the DIMension command via the DRAW menu option. By clicking button 1 with the cursor at the beginning of a line (or the corner of a rectangle, or the edge of a circle, etc.), you tell Cadplan the point from which it is to start taking measurements. When you click at a second location, the point-to-point measurement is displayed. The second point can be confirmed by clicking button 2 on the mouse, or it can be moved elsewhere.

The final submenu option ERASE, is used to erase parts of drawing in a reverse order; that is, the last line or shape drawn will be erased one vertex at a time; then the next-to-last item will be erased, and so on. This is a useful tool that lets you painlessly recover from errors. The only problem is that if you remove lines that overlap other lines, your drawing starts looking as though it's been eaten by moths. You must ask Cadplan to remap the screen after part of an image has been removed.

(Continued on page 91)

SIDEWAYS

Handy utility for printing wide spreadsheets

BY MICHAEL K. GUTTMAN

OUR software shelf is now filled with multi-function products, each claiming to be more "integrated" than the last. It's unusual—and refreshing—to find an unpretentious product that simply and inexpensively handles just one problem well.

One such product is Sideways, from Funk Software. Users who regularly deal with wide spreadsheets will delight in this practical utility. Ordinarily, printing spreadsheets means breaking those too wide for standard paper into pages that fit the printer. Afterwards, the printouts must be glued or taped together for the spreadsheet to be seen in its entirety.

Some printers permit a wide printout with compressed fonts on 15" paper. Printing still wider spreadsheets generally is a clumsy process and, with some compressed fonts, yields a result of unsatisfactory legibility.

Specifications

Product: Sideways
Mfr: Funk Software
PO Box 1290
Cambridge, MA 02238
617-497-6339
Price: $60
Requirements: IBM PC/XT or compatible; parallel/serial interface; Epson MX-80/100, Epson FX-80/100, IBM Graphics Printer, Okidata Microline series, C. Itoh Prowriter, IDS Prism, 460 or 560 printer

Sideways solves this problem by simply printing out the spreadsheet vertically, that is, rotating the characters 90 degrees. Sideways works with a number of popular spreadsheets: Lotus 1-2-3, VisiCalc, Multiplan, and SuperCalc-2. It also works with a number of popular dot matrix printers, including the IBM Parallel Printer and most models from Epson, IDS, Okidata, and C. Itoh.

Using Sideways is straightforward. You begin by "printing" out the spreadsheet to disk in an ASCII-style text file, which is what you would usually do to turn a spreadsheet into a word processing document (Sideways will work on any wide document, not just spreadsheets). Then you leave the spreadsheet program and invoke Sideways from DOS.

Once running, the program displays its one-page options menu. Using the arrow keys, you move from option to option and set various parameters, including vertical and horizontal page size, double or single strike, character font size, left and top margin size, and character and line spacing. With these options set, you move to the file name option, type the name of the desired file, and Sideways begins to print. If necessary, you can stop printing any time by typing a P. When printing is complete, Sideways returns to the options menu. Using the most condensed settings, I was able to get 136 rows onto a 14" page. If the spreadsheet has more rows than the settings allow, Sideways prints out the spreadsheet in sections in order to minimize the number of sheets that have to be glued together.

The documentation that comes with Sideways is clearly written. Besides providing instructions for normal operations, the manual carefully describes certain unusual problems you might encounter when printing out exceedingly large spreadsheets and ways to circumvent them.

Sideways is well thought out. Printing takes a little longer, but the tremendous flexibility of the product is well worth the delay. It's amazing that someone hadn't thought of this before, but apparently Sideways is in a class by itself. The overall result is a very pleasing product that works as advertised. Sideways is perfect for spreadsheet users eager to put away their glue pots and get on with their work. ◇

PHOTOS BY STEVE BORNS

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LOOKING INTO MONITORS

With more monitors than ever before available, here is what you need to know to choose the right one for you

BY MARTIN PORTER

It can be argued that microcomputers gain much of their appeal from our modern love affair with the TV screen. The right "one-eyed monster," with just the right bells and whistles, can draw users back to their machines time and time again.

As the number of personal computers has grown, so has the variety of video displays available for them. Some monitors are brighter than others, some present more detail. Meanwhile television manufacturers, discovering a nice profit center, are redefining their broadcast product lines to satisfy the needs of consumers who spend as much time at word processing or creating spreadsheets as they do watching prime time TV.

The heart of a computer monitor, or a TV set, is a cathode ray tube (CRT). It is a large vacuum tube whose face, or screen, is coated with phosphors that glow when a beam of electrons is directed at them. An image is created by varying the intensity of the electron beam as it scans repeatedly across the screen from top to bottom. (See the accompanying article on "Video Signals and Monitor Design.")

The quality of the image you see is determined by three primary factors: the speed at which the video information is delivered to the monitor, the scanning speed of the electron beam, and, in the case of color monitors, the number of phosphor dots, bars, or lines there are.

The Heights of Resolution

Manufacturers express the resolution of their monitors in terms of picture elements, or pixels, or lines. Horizontal resolution is measured from the left to the right of the screen. If it is given in lines, the number quoted represents how many lines can be made out as individuals before they blur together. Get up very early some morning and watch a TV test pattern. You'll get the idea. If pixels are quoted, it's the number of dots that can be displayed without their running into one another. A good black and white TV receiver has a horizontal resolution of about 500 lines or pixels. Vertical resolution may also be stated in terms of lines or pixels. Again, the same criteria hold.

Resolution is usually given as $x \times y$; where the first figure refers to the horizontal resolution and the second to the vertical.

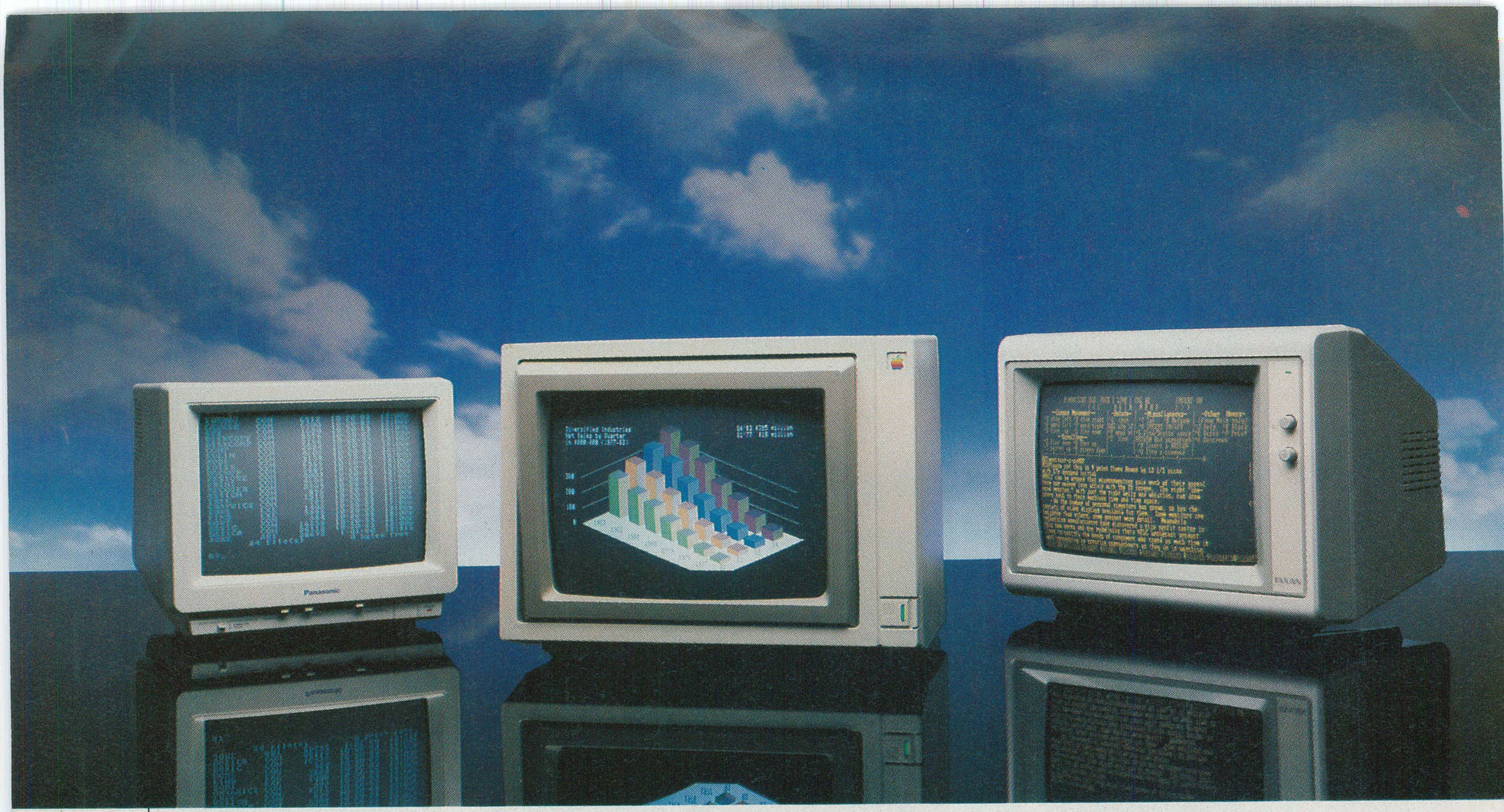
When reading manufacturers' specs, bear in mind two things.

First, resolution is best at the center of the screen and falls off as you approach the edges. Naturally, the figures quoted by manufacturers refer to measurements made at the center. Second, do not confuse the resolution figures quoted for computers with those for monitors. A monitor with 1000 lines of horizontal resolution will not display 1000 pixels if the computer can produce only 600 pixels or lines.

Since the number of pixels that can be displayed is a function of screen size, this specification on its own can be deceptive. Perhaps a better way to compare the resolution of color monitors whose screen sizes vary from 10″ to 25″ is through dot pitch (see the accompanying figure). It

Martin Porter writes about computer related electronics for a number of periodicals and newspapers.

PHOTO BY BARRY BLACKMAN



A variety of monitors, left to right: Panasonic's DT-S101 composite, Apple's 100 RGB, Taxan's KX-1203 amber

indicates how densely the color phosphor elements are packed together on the face of the CRT. As a rule of thumb, a dot pitch less than 0.40 mm indicates a high-resolution screen, and a dot pitch greater than 0.60 mm a low-resolution one. Screens with the highest resolution, such as the NEC Home Electronics' 12″ model JC1203DH, which sells for about $700, have a dot pitch of 0.31 mm. Monitor designers maintain that the next generation of RGB displays will have improved dot pitches, on the average, 0.25 mm.

Seeing Red, Green, Blue, etc.

Monitors, of course, can be monochrome or color. A monochrome monitor uses only a single phosphor type, white, green or amber, that is spread in a continuous layer across the face of the CRT. Accordingly, it is relatively simple to achieve high resolution with it. A color monitor, on the other hand, uses triads of color phosphors, arranged as groups of bars, stripes or dots on the face of the screen. The triad components—red, green and blue—glowing at various intensities, will produce almost any color imaginable. The resolution of the color CRT is determined by the size of these phosphor elements, and the number of color triads on the face of the tube.

Color monitors fall into two categories, depending on the type of video signal they can accept.

One, based on conventional color-TV technology, uses composite video, where all the color, brightness and sync information is combined into one signal that is decoded by the monitor.

The other is RGB (for Red-Green-Blue). This technique sends the red, green and blue color signals (one for each electron gun) to the monitor separately, along with a separate sync signal. More precise control of color is possible than the composite video technique allows. RGB monitors, producing purer colors with better differentiation and sharper borders, have become essential for anyone interested in quality on-screen color graphics. Many new consumer color TVs feature an RGB input, so the sets can do double duty as video entertainment centers and computer peripherals.

Many new color TVs double as video centers and computer peripherals

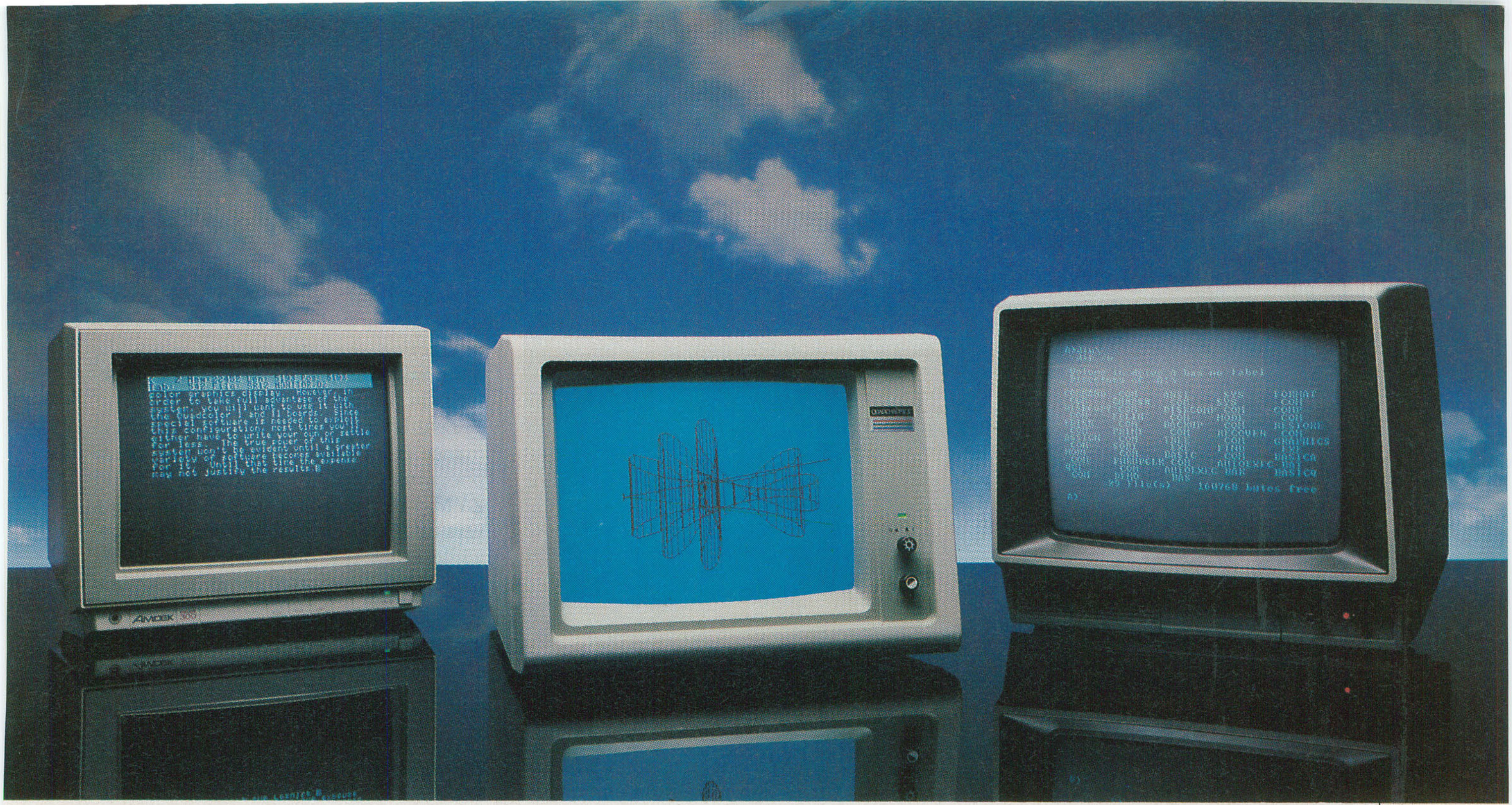
Which Monitor Should You Choose?

Monochrome screens are standard for applications that primarily involve plain text and numbers (i.e., word processing, spreadsheets, database management). Color may add some value, but nothing you can't live without. Typically, monochrome monitors have very high resolution—providing crisp readable characters—at a much lower cost than color monitors offering comparable resolution.

For instance, the 12″ Taxan Model 116 monitor is a monochrome standby that offers a high-resolution amber display of 1000 horizontal pixels for about $180. Most monochrome screens can resolve at least 800 pixels horizontally. In comparison, Princeton Graphics Systems' HX-12 color monitor has a claimed resolution of only 690 pixels horizontally, and its price, at $700, is well beyond the monochrome range. While monochrome monitors vary in price from $100 to $400, RGB color monitors start at about $500 and go to well over $1000. Composite color monitors are available at lower prices, generally between $300 and $400, but they may offer only a third of the resolution of a comparably priced monochrome unit. Thus, composite color monitors are generally used when the display will not exceed 40 characters per line instead of the 80 or more that can be displayed on a monochrome or RGB screen.

Still, composite monitors are adequate for many home uses. They provide suitable color and definition for computer games, educational programs, and simple color graphics like bar charts. Programming in BASIC, for that matter, requires only a 40-character display. If a program statement is longer than that, it will wrap around to the next line.

A typical composite color monitor—USI Computer Products' Model 1400C, for example—claims a resolution of 260 by 300 pixels. The Amdek 13″ Color 300



composite, Amdek's 300 composite, Quadram's Quadchrome II RGB, and Zenith's ZVW-131 composite/RGB.

composite monitor ($349) has a quoted resolution of 260 by 300 pixels. The Panasonic DT-s101 ($330) provides resolution almost as good on a 10" display. A switch allows you to change modes between color graphics and black-and-white text.

RGB Monitors

High-resolution color graphics demand an RGB monitor. The degree of resolution and the number of colors that can be produced, which vary widely among models, are important considerations for displaying three-dimensional graphics with more precise gradations of color than flat charts.

A few low-cost RGB monitors, such as Zenith's ZVM-131 (which also has a composite mode) at $380, provide a resolution of only 390 by 250. (Generally, a product with more than 500 pixels horizontally and 320 or more vertically is considered high-resolution.) Most RGB monitors, however, provide a horizontal resolution of about 600 pixels, though even this can be improved upon. Conrac Corporation, for instance, markets a line of ultra-high-resolution monitors with 13" and 19" screens with resolutions of 1080 by 809 pixels. You pay for this precision, however (the 19" model costs close to $4000), and you had better be sure your computer and software are worthy of the monitors' capabilities.

RGB monitors commonly are capable of displaying 16 colors (including black and white). The Quadram Corporation's Quadchrome monitor meets this tacit industry standard, but the Teknika Electronics TDC-1202 offers 27. Though many manufacturers don't bother to specify the maximum number of hues the products can reproduce, there are monitors that can display 64 colors with the proper hardware interface and driver software. Some systems, controlling each pixel that appears on the screen with an 8-bit code, can produce as many as 16 million color gradations.

Besides being matched to its intended applications, a monitor should also be matched to the capabilities of the computer with which it will be used. For example, the IBM Color Graphics Adapter Card can generate 16 colors (although only four simultaneously) at a resolution of 320 by 200 pixels. The purchase of a monitor like the Amtron 130B, which has an 850 by 640 resolution and costs about $1500 to use with this board would be a serious case of "overkill" as well as a waste of money.

Compatibility and interface requirements are the monitor shopper's top priorities

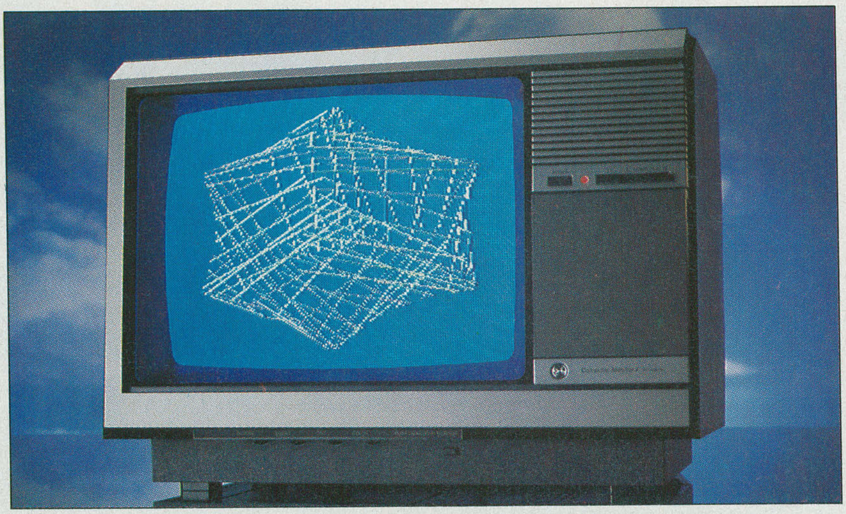
Attention to compatibility and interface requirements is the monitor shopper's most important priority, since the adapter card needed to connect a monitor to a computer may be a steep expense itself. A new RGB monitor marketed by Apple, the AppleColor Monitor 100 ($599), connects directly to the color video port on the Apple III and Apple III+, but a special AppleColor Card costing about $300 must be installed in an expansion slot of an Apple IIe to make it work with that computer. Amdek sells a $180 interface board to allow its RGB Color II Plus monitor to be used with the IIe.

A high-resolution monitor, such as the new SR-12 from Princeton Graphic Systems, requires that company's $250 Scan Doubler card to be used with an IBM PC or PC-compatible computer. (See the review in this issue.) That's in addition to the $800 cost of the monitor. The Scan Doubler generates two horizontal scan lines for every one generated by the PC's color card, producing a better-defined screen image of 480 lines. The Roland CC141 color monitor, meanwhile, sells for about the same price as the SR-12 and connects to the PC with a cable costing only $30 but doesn't match the SR-12's vertical resolution. The CC141 requires a $120 interface card from Roland to work with the Apple II and IIe.

Scan Rate and Bandwidth

The rate at which the electron beam scans the face of the CRT is another important factor in determining the quality of the display. We can talk about both vertical and horizontal scan rates. If the vertical scan rate, which is given in fields or frames per second (just like a motion

PHOTOS BY DAVID ARKY



This unit, from General Electric, serves as both color TV receiver and computer monitor.

picture's) is too slow, the image will appear to flicker. The standard scan rate is 30 frames per second, with each frame being made up of two interlaced fields. You could say that the vertical frequency of the monitor is 60 fields per second, or 60 Hz (cycles per second). This is the rate used in the NTSC broadcast system.

A horizontal scan rate of 15.75 kHz—that is, 15,750 horizontal scan lines per second—is common in color monitors. Again, it is the NTSC standard. An ultra-high-resolution monitor, though, such as Princeton Graphic's SR-12, has a horizontal scan rate of 31.4 kHz. And while most monitors use an interlaced scanning system (where one field contains the odd-numbered lines and the other the even-numbered ones), the electron beam in the SR-12 crosses the screen fast enough to draw each of its 480 lines on every vertical sweep, providing noninterlaced scanning for better resolution.

Considerable improvements are being made in scan rates. Expect RGB monitors in the next few years to have, on the average, a horizontal scan rate of 25 kHz. Naturally, the finer the dot pitch and the larger the screen size, the faster the beam must scan to maintain a flicker-free image.

Fast scan rates require the rapid-fire delivery of information. Thus, resolution depends ultimately on the bandwidth of the monitor—a factor that determines how quickly it can accept data from the computer. While composite video monitors usually have a maximum bandwidth of 6 or 7 MHz (with some combination composite/RGB monitors, such as Sanyo's AVM 196 and AVM 255, working in the same range), RGB monitors typically feature bandwidths of 15 to 20 MHz. Ultra-high-resolution monitors that are now entering the market, for example. Hitachi's 19" HM3619A and HM4619 ($7200 and $7500, respectively), have bandwidths greater than 40 MHz.

Other Technical Considerations

There are a number of other technical considerations to take into account when looking for a monitor. We'll discuss most of them just briefly here. (You can find more detail in the accompanying article in this issue, "Video Signals and Monitor Design.")

One factor is convergence: how accurately the electron beams in the CRT hit the phosphor elements they're aimed at. Convergence becomes more of a problem as you move away from the center of the screen. At its worst, misconvergence can create color fringes around images and seriously degrade resolution.

Vendors specify this parameter by measuring, in fractions of a millimeter, the farthest an electron beam might stray from its target, both at the center and at the corners of the screen. Typical measurements for mid-range-priced monitors like the composite and RGB displays from Algol Technology are 0.6-mm misconvergence at the center and 1.2 mm at the corners.

A professional monitor, such as Conrac's 7211C13, reduces the maximum convergence error at the center to 0.25 mm, and to 0.7 mm at the corners. Similar precision is available at a much lower cost in Panasonic's high-end 10" monitor, the DT-H103, which sells for about $750.

Another point to take into consideration is phosphor persistence—how long the phosphor glows after it has been excited by the electron beam. The phosphor compounds used on different CRTs have different persistence characteristics, and while long persistence helps reduce flicker, it may also produce distracting smudged images when the material being displayed changes quickly, as in the case of scrolling text.

Zenith boasts flicker-free performance from the long-persistence phosphors used in its 13" ZVM-133 and ZVM-136 RGB monitors running at a vertical scan rate of 40 Hz. Sharp, meanwhile, is just as proud of the short-persistence phosphors used in its smear-free RGB model 12M.22U monitor, which uses the normal 60-Hz refresh rate.

Readability

Other features may be important to a user's comfort or taste. Monochrome displays, for instance, are commonly available in green or amber (black and white is by now rather passe). Green phosphor monitors came first, to ease the effect of staring for hours at a bright black-and-white screen. Amber is a more recent enhancement, and it seems to be winning more and more adherents who find its muted shade to be easier on the eyes than green. Amber phosphors also have a shorter persistence and eliminate the green smear some monochrome monitors produce when text is scrolled.

Green phosphor screens are also known to produce a "pink effect" for some users—after long sessions they see a pink glow on white surfaces. Amber apparently does not have an equivalent side effect.

Some manufacturers charge more for an amber screen. USI Computer Products, for example, sells its high-resolution 9" and 12" monochrome monitors (with horizontal resolutions of 1000 and 800 lines, respectively) for about $25 more for the amber version than for the green. A new product from Sanyo, its Model DMC 6600, is a medium-resolution monitor with both composite and RGB inputs, that lets you switch to a monochrome mode and choose between green and amber.

Other factors affecting readability are screen brightness and contrast. A growing number of manufacturers market monitors with "black matrix" screens, where the screen surface surrounding the phosphor material is colored black to set off the glowing color sharply. Sanyo's AVM 258, a 25" TV, provides a rather high 400-line composite video resolution with this high-contrast feature.

The color of the glass faceplate over the screen also affects contrast, and a

(Continued on page 50)

PHOTO BY DAVID ARKY

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Monitors
(Continued from page 48)

dark faceplate may enhance the quality of the display. A Mitsubishi monitor, the AM-1301, for instance, uses a tinted faceplate that absorbs rather than reflects ambient light.

Another common feature used to make viewing easier is an etched glass faceplate that reduces glare.

Finally, there's the ergonomic factor—the human-monitor interface. While it is always possible to shift the monitor to the right or left and to prop up the front with a phone book to set the screen at just the right angle for viewing, these *ad hoc* adjustments are not the most elegant way of solving the problem.

Amdek sells an accessory base for about $40 for its 13″ color monitors that allows the user to swivel the display from side to side and to tilt it up and down. Sakata sells a similar stand for its color monitors. And the Curtis Manufacturing Company sells a tilt/swivel base for the IBM PC color and monochrome displays for about $80, a $10 adapter for that base to accommodate Princeton Graphic Systems and Quadram units, and another model for about $50 for all other non-IBM monitors.

TV or Not TV?

Since computer monitors and television sets are based on the same raster-scan technology, what's the point in investing in two separate units? Unfortunately, the average composite-video TV set can't cut the mustard as a computer peripheral.

Moreover, while some microcomputers can produce a r-f-modulated signal that can be applied to a TV receiver through its antenna connector, the result is usually a display full of video noise generated by the rapid switching of the computer's logic circuits.

To avoid such noise, more TV models on the market today are offering a direct video input (useful also for other devices such as VCRs and videodisc players). Still other receivers are sporting RGB inputs, so they can provide high-resolution graphics when connected to the output of a computer's color board.

Mitsubishi's AM-1301 is such a hybrid unit. With an 8-pin RGB jack as well as a direct composite video input, the 13″ AM-1301 provides a resolution of a healthy 560 horizontal pixels in RGB mode.

A 13″ Sears model 4084 TV receiver is a good buy at $340, with selectable composite and RGB inputs, providing a me-

TOUCH SCREENS

A COMPUTER monitor can be more than just a video display. If it also has a touch-sensitive screen, it can become, like a mouse or a trackball, an alternative input device.

Hewlett-Packard introduced touch screen technology to consumers with its HP-150 computer in the fall of 1983. And, while it hasn't been followed by a rush of copycats, several monitors do incorporate touch screens.

Sony's new 19″ PVM-1911 RGB color monitor, which sells for about $1500, is one of the few such consumer units. This monitor, which can be connected to Sony's own SMC-70 and SMC-70G microcomputers, features an interface for use with the IBM PC. Interactive Images also sells a touch screen monitor with an adapter card and a software package called Easel (about $1650 in all) for use with the PC as well as with micros from AT&T, Motorola and others. However, the company's biggest clients are still the OEM market.

The reason for the industry's restraint in this area is continued doubt about consumer acceptance of the finger-pointing technique. According to George Weiss, director of computer systems studies for Quantum Science, a New York market research firm, the touch tablet and mouse have proved to be more popular devices for interacting with computers.

However, says Weiss, touch screens are useful and have become increasingly common for commercial applications in hotel lobbies, train stations and airports. Bankers and retailers find the technology well suited for remote transactions from a customer's home, and for industrial applications, where dirt would foul a keyboard, it's ideal.

This commercial market is big enough

Hewlett-Packard 150 touch screen.

to support a large number of OEMs, including Carroll Technology of Round Rock, TX; Elographics of Oak Ridge, TN; and Santa Barbara Development Laboratories in California.

A Touchy Subject

Touch screens are not perfect, however, and have their share of ergonomic drawbacks. In applications like word processing repeated arm movement between the keyboard and the screen can be straining. There have also been problems with fingertip accuracy, that is, hitting what you aim for.

The HP-150, for instance, uses an infrared technique that relies on a grid of light beams crossing in front of the screen. Sensors detect the coordinates at which the beams are broken by a fingertip. While the process may seem foolproof, parallax effects frequently interfere. Depending on the user's line of sight, the item pointed at on the screen and the beam coordinates may not coincide. Furthermore, the fact that the infrared beams are broken before the finger reaches the screen may also lead to errors.

The resistive membrane technology used in the Easel system—here the finger presses together electrodes implanted in a pair of Mylar sheets right in front of the screen—avoids these problems to some extent. It also offers very high resolution, with as many as 700,000 distinct points.

Of course, a fingertip is not a fine enough pointing device to pick out such minute spots, but engineers feel this technology may be useful in the future for creating rough drawings on a monitor that can be converted by software into precise line drawings.

Touch screen proponents also maintain that its potential applications go beyond using modified versions of popular software on computers such as the HP-150. Most agree, however, that software developers will have to find the right applications that make the pointing finger the appropriate interface to the computer.

Some proponents are unequivocally optomistic. Leonard Hafetz, president of Interactive Images, insists that "... in the next year or so everybody is going to see the 'light' about touch." ◇

dium-resolution RGB image on a 0.50-mm dot-pitch screen. Sony's line of Profeel video monitors also has RGB inputs for use with microcomputers. (Telemax markets a $139 interface for connecting monitors to the IBM PC, but Sony has begun to market its own PC interface for the bargain price of $80.)

The GE model 13BC5509X color computer monitor/television offers an unusual feature—a width control to keep information from spilling off the edge of the screen.

And, just as TV manufacturers are moving into the monitor field, so are the producers of monitors invading TV territory. The Zenith ZVM-131 composite color monitor can be connected to a modular tuner to display high-quality broadcast television. Taxan also markets a TV tuner, reviewed in this issue, to connect to its own combination composite/RGB Model 210 monitor (or to any other monitor that has an audio output). The Model 210, with a respectable composite resolution of 380 by 262 pixels, can, with the tuner, beat many conventional television sets for picture quality.

Making the Decision

With so many variables to consider and products to choose from, what is a monitor shopper to do? The real test of any computer monitor is your own opinion of its performance. Here are some tips to help you make your evaluation:

Visit a retail outlet and watch it in action. Make sure the monitor you examine is connected just as you would be using it—with the same computer and adapter card as yours.

Fill up the screen with characters to see whether they get fuzzy or develop off-color fringes at the corners and edges of the display. Make sure the entire image is displayed (some units may have too much overscan, which can cause the edges of the picture to disappear off the edges of the screen). Make sure that straight lines are really straight. Watch for flicker or smear. In the case of a color monitor, examine the colors to see how rich, solid, graduated and sharp they are.

Above all, try to get a feel for the size of the screen, its brightness and contrast, and find one you feel comfortable with.

Selecting a monitor, as a New York computer dealer remarked recently, "... is one of the most subjective areas of computer buying. In the end, your selection of a monitor depends on which one winks at you." ◇

THE BIG PICTURE

THE "micro" in "microcomputer" doesn't have to mean "micro-monitor." Those who want "the big picture" can connect their computers to color TV sets or large-screen monitors equipped with RGB inputs. If they are not satisfied with even 25" CRTs, they can turn to projection TV.

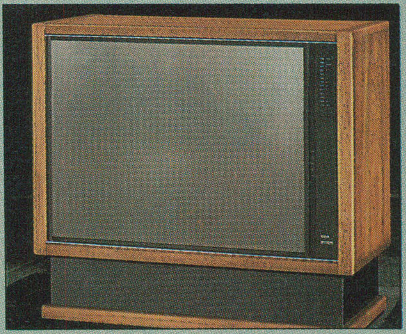
About ten years ago projection TV became a barroom attraction, drawing crowds of sports fans to watch the action on large screens. Since then it has found its way into homes, providing theater-like reproduction of television broadcasts and prerecorded materials.

Several projection TV manufacturers now market their systems with RGB connections, making the large screen suitable for color computer displays.

Henry Kloss, a pioneer developer of projection television and the founder of Kloss Video Corporation, says his company's sales efforts for large-screen computer display projection are aimed at business users. But he doesn't deny that others will also want to put their computer displays on 6' screens.

Kloss Video markets a home-oriented projection TV with RGB inputs, the Novabeam Model One-A, for about $3700. The unit, available with or without a TV tuner, can project either a 6½' or 10' (diagonal) picture. Using the curved high-gain screen that comes with the 6½' version, the Model One-A produces a picture bright enough to be watched under normal room lighting.

Kloss also sells a projection unit especially intended for computer color graphics, the Videobeam 2000, which costs about $6000. Like the Model One-A, the Videobeam 2000 can be ordered in either the 6 ½' or 10' format. It features a high-resolution picture (1000 horizontal lines) and in the text mode can display either 80 or 160 characters per line.



RCA's ColorTrak monitor/receiver.

There are other projection units better suited to household proportions . . . and budgets. RCA markets a medium-resolution rear-projection television with a 40" diagonal screen as part of its Colortrak 2000 series. Its Model PKC400 has RGB inputs and sells for about $2900. Sony's VideoScope projection system model KP-7225 costs about $3000 and projects computer images on a 6'-diagonal screen that stands above a coffee table style projection box.

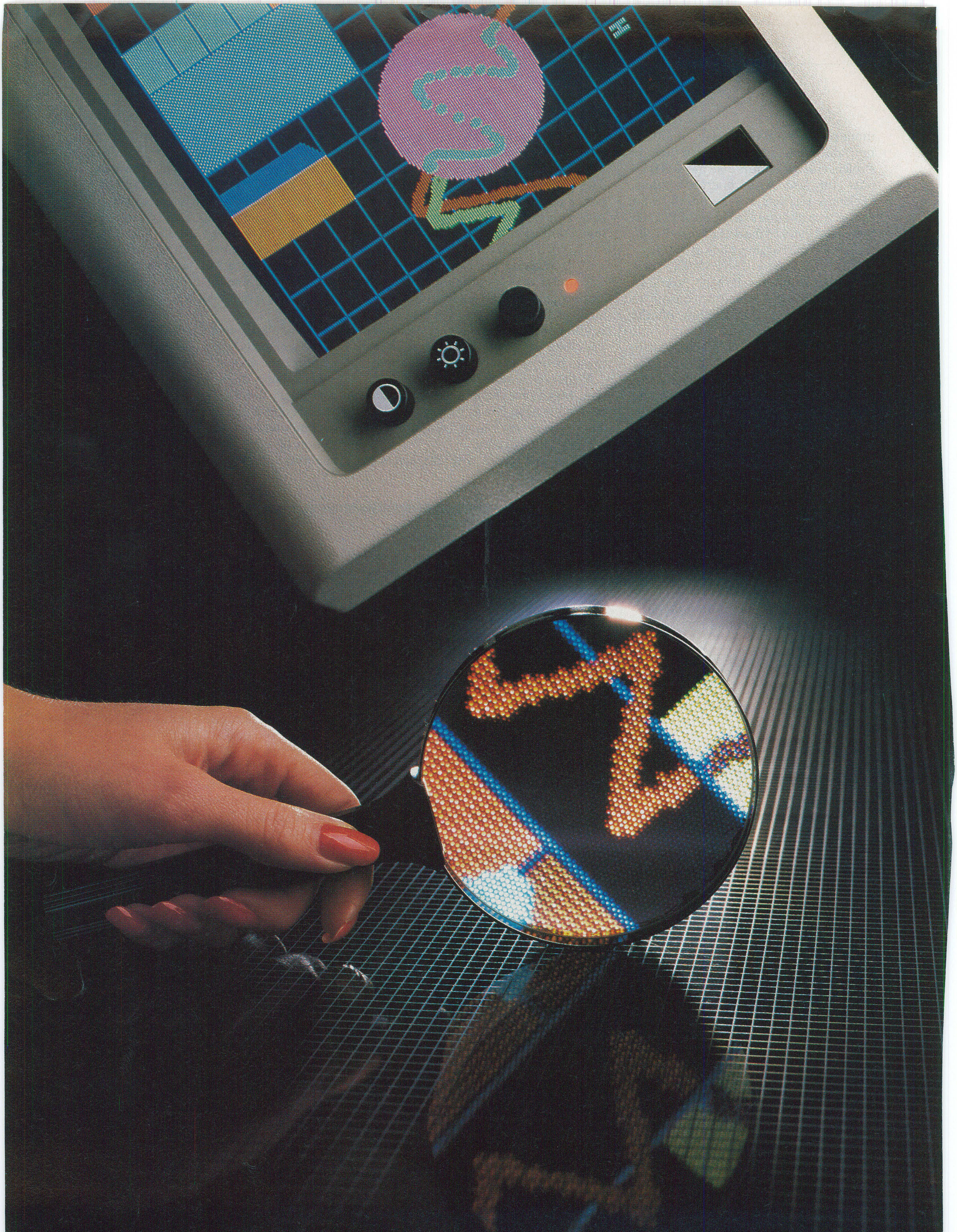
At the high end of the scale are units such as Electrohome USA's ECP-1000. Users can modify it to project a picture ranging in size from 4.8' to 6' diagonally, and a further, more extensive, modification can bring forth a 10' image. The ECP-1000 costs nearly $15,000. Electrohome also sells a monochrome green data/graphics projection unit—the EDP-57—that is capable of 1000-line resolution, for about $5000.

Even Larger Screens

If a 10' picture is still too small for you, try your graphics on the Barcovision II, marketed by Elector USA. It comes in three different models, producing pictures measuring 10', 17.5' and 31' on the diagonal. These sell for just under $10,000 and their top-notch resolution uses the same high (32 kHz) horizontal scan rate as the Electrohome ECP 1000. Another Elector projection unit, the Barcodata II, costs around $16,000.

Despite recent improvements in projection TV resolution and brightness, Henry Kloss sees little room left for fundamental advances in this technology: "The phosphors, the optics and the screens have been made as efficient as possible." Further developments, he says—"playing with the signal" to eliminate video noise and increase effective bandwidth—will be refinements of general television technology.

The really ambitious big-screen television project is not a projection technique at all, he adds, but a large, flat, wall screen that generates its own light. That screen may be available in another decade but, he points out, developers were saying the same thing 20 years ago. ◇



VIDEO SIGNALS AND MONITOR DESIGN

Everything you ever wanted to know about monitors but were afraid to ask

BY LES SOLOMON

THE most common interface between a person and a computer is a video monitor. The image the user sees on the monitor screen is the result of a "video signal" transmitted to the monitor from the computer. This article will provide some explanation of what this signal is.

The Raster

The image on the screen of conventional video displays is created by variations in the instantaneous brightness of a series of "pixels" (for "picture elements") along the horizontal scan lines crossing the face of the CRT (cathode ray tube) from top to bottom. This series of lines is called the "raster."

In theory, the first horizontal line starts at the upper left-hand corner of the screen and crosses in a smooth, relatively slow, trace, leaving a bright line behind it due to the afterglow of the phosphor that has been excited by the electron beam. When the trace arrives at the right side of the raster, it is very rapidly retraced to the left side, where the sweep starts again. Typically, one horizontal sweep takes about 63 microseconds, with the retrace interval being a fraction of that time.

Simultaneously with the horizontal sweep, a relatively slow (1/60 second) vertical sweep causes each horizontal line to start lower and lower with each successive sweep. This combination of horizontal and vertical sweeps causes the raster line to slant down slightly to the right, as can be seen in Fig. 1. Special circuits within the sweep system blank out the retrace lines so they are not visible on the screen.

The combination of the afterglow of the phosphor on the face of the CRT and of the eye's persistence of vision results in a visible raster—the canvas on which the video signal will paint its images.

Flicker

After the horizontal sweep reaches the bottom of the CRT screen, the signal returns rapidly to the upper left-hand corner of the screen, completing one "field" in 1/60 second. Two fields make up a "frame," which takes 1/30 second to be displayed. Why fields and frames? The reason is "flicker."

Neither TV pictures nor movies actually move—they are simply series of still images, each slightly different from the next. When viewed one after the other, they give the illusion of motion.

Although the human eye becomes unaware of any discontinuity of motion when images are viewed at the rate of 15 Hz (cycles per second) or faster, it can detect flicker at much higher frequencies. In video equipment, flicker varies with picture brightness, viewing angle, and certain physiological factors. To eliminate flicker, the vertical scanning frequency must be greater than the rate at which flicker is discernible.

Les Solomon is Technical Director of COMPUTERS & ELECTRONICS.

A series of visual tests determined that for a smooth TV image, the vertical scanning frequency must be at least 50 Hz to avoid all sensation of flicker in a bright picture. The motion picture industry, using a projection rate of 24 frames per second, solves its flicker problem by using a special shutter in the projector that shows each frame twice and yields an effective frame rate of 48 per second. While satisfactory for movies, this rate is still a trifle too slow for brighter video displays.

Since U.S. utilities use a power line frequency of 60 Hz, 30 was chosen as the field frequency. Using two fields per frame produces a smooth flicker-free raster on the CRT screen at a 60-Hz rate.

Interlace and Pairing

The National Television Systems Committee (NTSC) specifies 525 lines per frame, each frame being made up of two $262\frac{1}{2}$-line fields. The interlacing of the two fields produces an image that is "smoother" and has less flicker. Odd-numbered lines are in one field, and even-numbered ones are in the next.

To arrive at the half-line, the bottommost horizontal sweep line actually ends halfway across the face of the CRT, while the topmost line of the following field starts at the halfway point of its first sweep line.

A problem that sometimes occurs in video systems is that the sweep synchronization circuitry fails to "recognize" the half-line start of each field and places

PHOTO BY DAVID ARKY

Video Signals

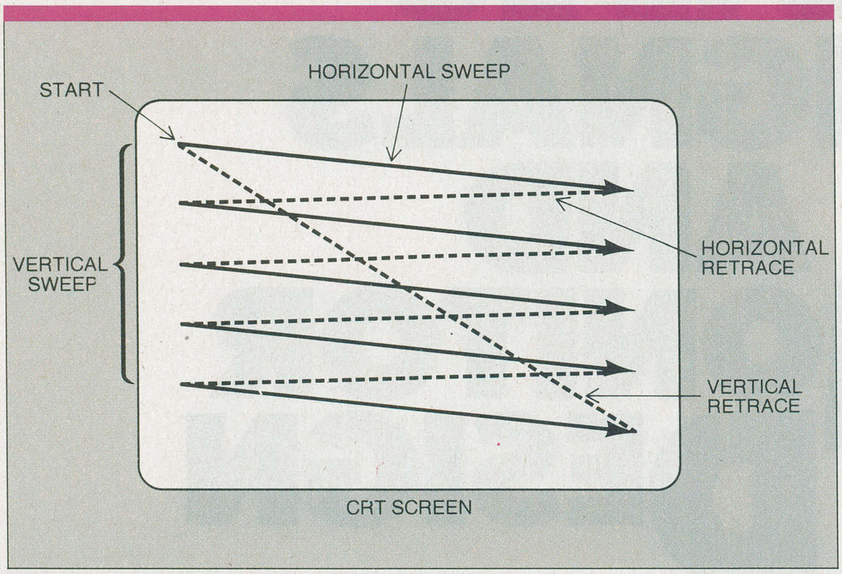


Fig. 1. Raster is scanned left to right, top to bottom.

the fields one on top of the other rather than side by side. Such "pairing" produces a much coarser display.

You can test your own video system for pairing by carefully watching the displayed raster, then slightly adjusting the vertical sweep speed (vertical hold) control. If the two fields are not interlacing properly, as the control is adjusted, you will see one field emerge from behind the other.

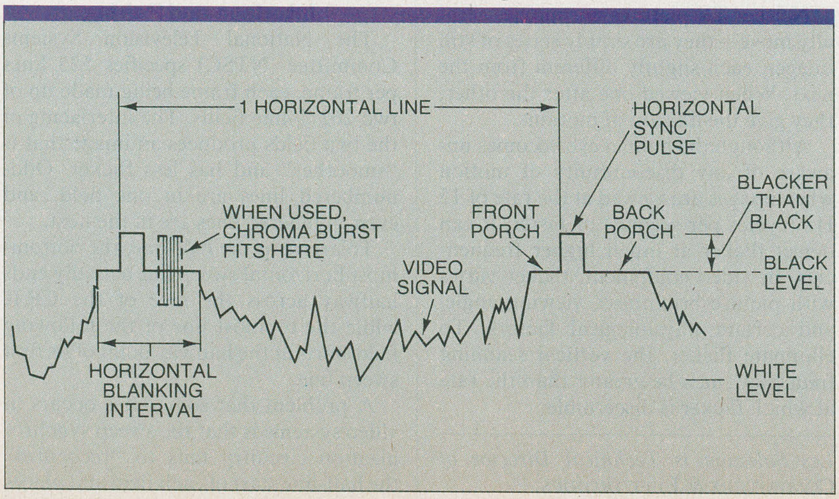
Note also that in many cases, if you do attain interlace, you may not have a stable display, depending on the quality of the receiver or monitor. In a video system that produces "pairs," the best vertical resolution you can obtain is 262½ lines—and that includes the 21 "invisible" lines that are part of the vertical retrace interval, that period of time when the electron beam is blanked as it goes from the bottom of the screen to the top to start a new field. You thought you had 512 lines. Now you may be down to just 241 (and a half)!

Vertical Resolution

Vertical resolution, the ability of a display to resolve *horizontal* lines, depends on the number of scanning lines used, which is also referred to as the "scan ratio."

In photography, when four black lines are separated by white lines of the same thickness, resolution is given as four lines. In video, all the lines are counted. The four lines of photographic resolution become seven lines of video resolution.

Fig. 3. NTSC vido signal. Vertical blanking interval is within horizontal blanking interval.



Vertical resolution is also a function of what is known as the *Kell factor*—the relationship between the diameter of the electron beam where it hits the phosphor and the width of the raster line produced. With the Kell factor usually given as 0.7 you determine vertical resolution by multiplying the number of active scan lines by 0.7. For example, if there are 260 scan lines, the vertical resolution will be 260 × 0.7, or 182 lines. In conventional 525-line video, the maximum resolution of the image will be 343 lines. (Bear this in mind when you're examining the accompanying Buyer's Guide.)

Horizontal Resolution

Horizontal resolution is the ability of a video display system to resolve *vertical* lines (although it is sometimes specified in terms of dots, or pixels). It is determined primarily by the bandwidth of the system, including the CRT. The expression "lines (or pixels) of resolution," refers to the number of black and white lines (or picture elements) of equal width that can be distinctly displayed horizontally across the CRT's screen.

The horizontal resolution of a system can be calculated by multiplying the bandwidth of the system by the active horizontal line scan time, and then multiplying that result by 2. For example, if we assume a bandwidth of 4 MHz and a 40-microsecond active scan time per horizontal line, the horizontal resolution will be (4,000,000 × 0.00004) × 2, or 320 lines.

As a rule of thumb, you can assume about 80 lines of resolution (not 80 characters!) for each MHz of bandwidth. Typically, the bandwidth of a TV receiver is about 4.2 MHz. That of a good color monitor can exceed 30 MHz.

Bandwidth and Characters

Most computer video outputs wait for a few microseconds at the beginning and end of each scan line so that the display will fall well within the boundaries of the CRT screen. A full scan line takes a little over 60 microseconds to produce; with blanking at the beginning and end we arrive at the 40-microsecond figure used in the horizontal resolution calculation just above.

Let's assume that we have a system that outputs 80 characters per line. This means that we are permitted 40 microseconds/80 characters, or 0.5 microseconds to display each character. If a dot matrix character generator 7 (wide) × 9 (high) is used (1 dot equals 1 pixel), each scanned line would have to display 7 character dots plus at least 1 dot space

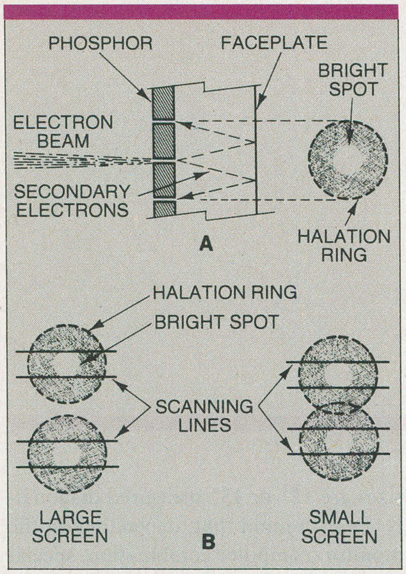


Fig. 2. Halation rings can decrease or limit resolution.

on each side—a minimum of 9 dots—during that 0.5 microsecond. That equals 18 dots in 1 microsecond, or 18 million dots per second. As a rule of thumb, the video bandwidth required for a crisp display can be estimated by dividing the number of dots displayed per second by 2.

According to this rule, a system must have a 9-MHz bandwidth to display an 80-character line. A 64-column display would require 7.5 MHz, while a 40-column one would need a bandwidth of 4.5 MHz—about what you would find in a very good TV receiver. If you attempted to increase the bandwidth of a conventional receiver to get a better image, you would be amplifying any electrical noise present in the system and degrading the image rather than improving it.

The greater the bandwidth of a monitor, the better the quality of the display. However, bandwidth comes at a price—money—so you will have to arrive at a happy medium between cost and display quality.

Display Crispness

In theory each pixel is a sharp point of light; in actuality, each tiny pixel is surrounded by a halo, called a Gaussian skirt, caused by secondary electron emission. As is shown in Fig. 2, when scan lines are close together, as they would be in a small-screen (say 9″) monitor, the adjacent "halos" will overlap, producing a smoother, but possibly less well-defined, display. This phenomonon can place a limit on the smallest screen size you can use practically.

The loss of contrast that results from the halo effect is expressed as the modulation transfer function (MTF), the ratio between the maximum small-area (pixel) and large-area (halo) contrasts. If there is no loss of contrast, the MTF is 1.0, 100%, or 0 dB. An MTF of 50% (−6 dB) is the limit for adequate performance.

The MTF can be improved by lowering the brightness and/or contrast of the image on the screen, which might dim the display. Fortunately, reflection-inhibiting CRT techniques (etching, for example) also lower the amount of contrast loss due to halation and can improve the quality of a display.

Neutral density or other optical filters used in front of the CRT screen can also enhance contrast and give a seeming improvement in readability. However, in many cases the use of such filters causes the user to turn up the display's brightness control. This enlarges the size of the on-screen pixels, which, in turn, produces a slightly defocussed (blurry) image. In a sense, the result is an "optical reduction in bandwidth."

At a typical 18″ viewing distance (eyeball to CRT), most users can distinguish dots spaced about 0.005″ apart. Since viewers usually feel most comfortable with bright, sharply focused images having a brightness ratio of at least 30:1, CRT screen filters should be chosen with care.

The "m" Test

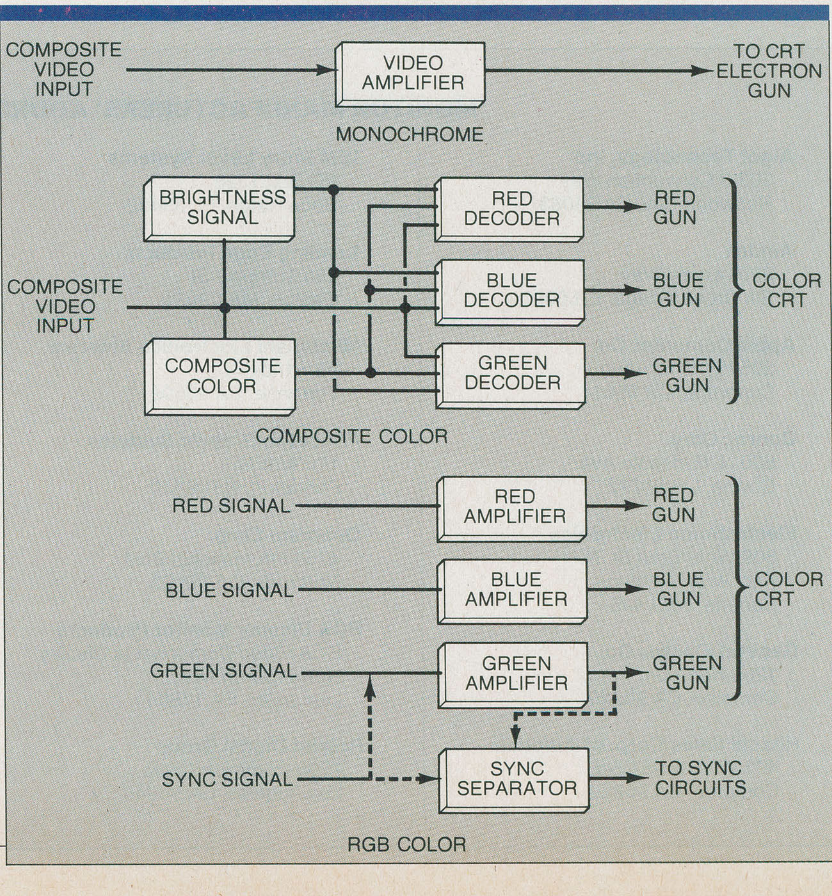
A quick check of the overall quality (bandwidth, focus, contrast, brightness, linearity) of a video display can be made by filling the screen with lower-case "m"'s.

In the case of most character generators, a lower-case "m" consists of three short vertical lines joined across the top by a horizontal line (which in the following, we'll ignore). Each of the three short lines is separated from the others by a dot-space, sometimes called an "undot." This pixel arrangement is very close to ideal for testing the maximum resolving power of a system.

Adjust the CRT brightness, contrast and focus (if it's adjustable) for the best display. Then take a close look at the screen full of "m"'s. At the center of the screen, each of the letters should be clearly defined. How well defined they are *away* from the center—at the edges and corners of the screen—can tell you a lot about the quality of the unit.

(Continued on page 78)

Fig. 4. From top to bottom: monochrome signal path, composite color signal path, RGB signal path.



BUYER'S GUIDE TO MONITORS

THE chart on the following pages is an overview of video monitors suitable for use with personal computers, listing the specifications we feel to be the most important. Because there are so many monitors available, we have divided the chart into three sections (monochrome, composite color, and RGB) and selected an appropriate model from each manufacturer.

Many more models than are shown are available; this is just a representative sampling.

Note that several of the color monitors also double as TV receivers. If you don't intend to dedicate the monitor exclusively to computer use, this may be an important consideration for you (and may to some extent justify the purchase of a color monitor).

Furthermore, the composite color monitors can be used with other video sources such as videodisc players and VCRs. If you don't require the high precision afforded by RGB monitors, a composite one may prove to be the better choice because of its versatility.

Unless otherwise stated, all screen sizes are 12″ or 13″ measured diagonally. Bear in mind that, depending on the monitor/computer combination, special cables may be required.

All figures were obtained from the manufacturers or from their literature. In certain cases, figures for vertical resolution could not be obtained. An "N/A" in a column indicates that the information was not available at press time.

For more information on specific brands or models of monitors, write to the manufacturers at the addresses shown below. ◇

MONITOR MANUFACTURERS' ADDRESSES

Algol Technology, Inc.
303-3 Convention Way
Redwood City, CA 94063

Amdek
2201 Lively Way
Elk Grove Village, IL 60007

Apple Computer Co.
20525 Mariani Ave.
Cupertino, CA 95014

Conrac Corp.
600 N. Rimsdale Ave.
Covina, CA 91722

Electrohome Electronics
809 Wellington St. N.
Kitchener, Ontario
Canada, N2G 4J6

General Electric Co.
1200 Kona Dr.
Compton, CA 90220

Hitachi Sales Corp. of America
401 W. Artesia Blvd.
Compton, CA 90220

IBM Entry Level Systems
PO Box 1328
Boca Raton, FL 33432

Leading Edge Products
225 Turnpike St.
Canton, MA 02021

Mitsubishi Electronics America
991 Knox St.
Torrance, CA 90502

Princeton Graphic Systems
170 Wall St.
Princeton, NJ 08540

Quadram Corp.
4355 International Blvd.
Norcross, GA 30093

RCA Display Monitor Products
RCA Video Components Display
New Holland Ave.
Lancaster, PA 17604

Roland Digital Group
7200 Dominion Circle
Los Angeles, CA 90040

Sakata USA
651 Bonnie Lane
Elk Grove Village, IL 60007

Sanyo Electric
1200 W. Artesia
Compton, CA 90220

Tandy/Radio Shack
One Tandy Center
Fort Worth, TX 76102

Taxan Corp.
18005 Cortney Ct.
City of Industry, CA 91748

Teknika Electronics Corp.
353 Route 46 West
Fairfield, NJ 07006

USI Industries
71 Park Lane
Brisbane, CA 94005

Zenith Data Corp.
1000 Milwaukee Ave.
Glenview, IL 60025

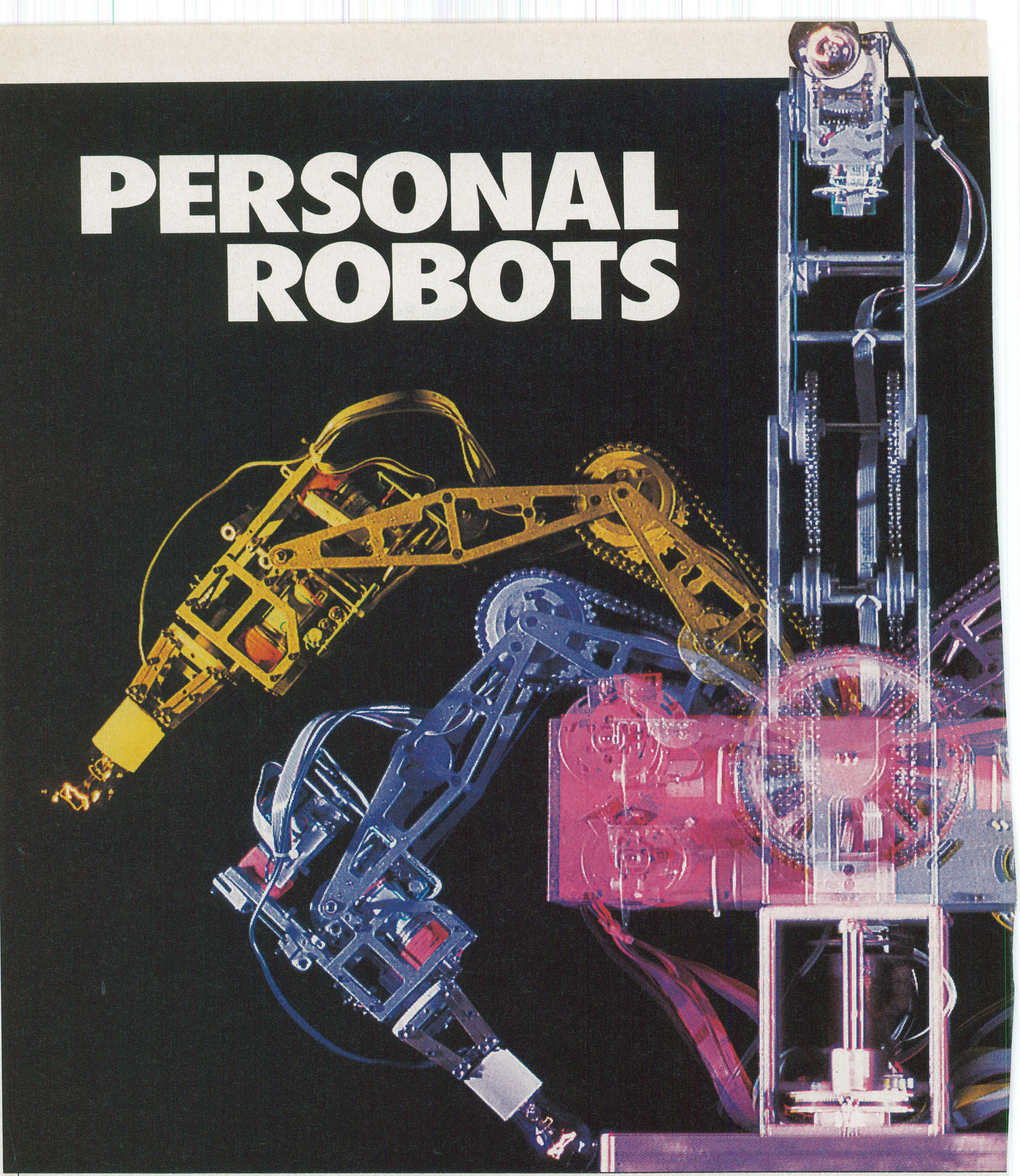
BUYER'S GUIDE TO MONITORS

Manufacturer	Model	Price ($)	Weight (lbs)	Dimensions W x H x D (")	Speaker(S)/ Audio(A)
Monochrome					
Amdek	Video 300	179	17	15x11x13	—
Apple Computer	Monitor II	229	21	15x11x13	—
Conrac	ENA12C	750	17	12x12x12	—
Electrohome	EVM 1220	619	25	14x10x14	—
General Electric	12XR5204X	139	16	13x14x13	S
Hitachi	MM 1218	210	16	13x11x13	—
IBM	Monochrome Display	275	17	15x11x14	—
Leading Edge	Green Screen	169	14	14x12x12	—
NEC	JB-1201M	199	13	14x12x13	A
Panasonic	TR-120M1PA	220	18	11x14x14	S
Princeton Graphic	MAX-12	249	23	15x11x15	—
Quadram	Amberchrome	250	19	11x14x14	—
Roland	MB1216	200	15	12x11x14	—
Sakata USA	SG-1000	129	17	12x11x13	—
Sanyo Electric	DM 2212N	118	17	16x11x13	—
Sears	57-H-5048C	98	19	15x13x11	S
Sharp	12M-15BU	199	14	11x12x13	—
Tandy/Radio Shack	VM-1	249	15	12x11x12	—
Taxan	116	180	15	14x13x12	—
USI Industries	1200/A	225	23	7x9x10	—
Zenith	ZVM-123	149	14	12x13x12	—
Composite Color					
Algol Technology	CM-13N	249	31	14x14x15	S
Amdek	Color 300	349	32	14x12x16	S
General Electric	13BC5509X	399	29	18x14x16	S
Hitachi	CM 1481B	340	26	17x15x15	S
Leading Edge	Color	500	24	14x13x15	—
Mitsubishi	AM-1301	600	31	15x15x15	S
NEC	JC1215	399	19	14x13x14	—
Panasonic	DT-S101	330	16	10x11x13	S
RCA	EKR360R	500	47	16x18x17	S
Roland	CC121	599	N/A	14x13x16	—
Sakata USA	SC-100	329	31	14x14x17	S
Sanyo Electric	DMC 5500	359	26	15x14x17	S
Sears	4084	340	36	13x14x15	S
Sharp	13M-31V	399	31	13x15x16	S
Taxan	220	350	41	15x14x17	S
Teknika	MJ-22	N/A	26	14x15x15	—
USI Industries	1400/C	398	29	14x13x14	S
Zenith	ZVM-131	379	38	14x15x15	S
RGB Color					
Algol Technology	CM-70	499	31	14x14x15	—
Amdek	Color 600	599	32	14x12x16	—
Apple Computer	AppleColor Monitor 100	599	33	15x11x15	—
Conrac	7211C13	3730	55	18x11x18	—
Electrohome	ECM 1301	1485	52	18x13x17	—
IBM	*jr* Color Display	429	26	14x13x15	S
IBM	Color Display	680	26	15x12x16	—
Mitsubishi	C-3470	N/A	29	11x14x15	—
NEC	JC1203DH	699	26	15x12x16	—
Panasonic	DT-H103	753	20	13x11x13	—
Princeton Graphic	HX-12	695	35	15x11x16	—
Princeton Graphic	SR-12	799	29	15x11x15	—
Quadram	Quadchrome II	599	32	16x12x16	—
RCA	FKC2022/3	1100	106	22x26x19	S
Roland	CC141	795	32	14x13x16	—
Sakata USA	SC-300	899	31	14x14x17	—
Sanyo Electric	DMC 8500	998	29	15x14x17	—
Sharp	12M.22U	549	23	13x11x15	—
Tandy/Radio Shack	CM-1	799	25	14x13x15	—
Taxan	440	800	24	13x11x15	—
Teknika	TDC-1202	N/A	24	14x15x12	—
Zenith	ZVM-133	559	39	14x15x15	—

** RGB specification for composite/RGB monitor.*

Bandwidth (MHz)	Resolution H x V	Phosphor/ Pitch (mm)	Scan Rate (H kHz,V Hz)	Comments
18	960	Green	15.750, 60	Also available in amber, 300A ($199)
18	900 (H)	Green	15.699, 60	
10	600 (H)	B&W	15.734, 60	
18	800 (H)	B&W	15.750-18.0, 40-65	Also available in green
N/A	450 (H)	B&W	15.750, 60	TV receiver/monitor
15	N/A	Green	15.750, 60	
16	640x200	Green	18.432, N/A	
16	N/A	Green	18.432,50	Available in amber ($174);TTL inputs only
20	640x200	Green	15.750, 60	Also available in amber, JB1205M
20	1100 (H)	Green	15.720, 50-60	Also available in amber, TR-120MDPA
18	720x350	Amber	18.432, 50	
20	720x350	Amber	15.750, 60	Plugs into IBM monochrome display adaptor
18	640x240	Green	15.750, 60	Also available in amber, MB121A
18	900 (H)	Green	15.750, 60	
15	600 (H)	Amber	N/A	Also available in green
3.5	500 (H)	B&W	15.750, 60	TV receiver/monitor
18	640x200	Green	15.674, 59.9	Also available in amber, 12M-15BUA
N/A	800 (H)	N/A	26.4, 60	
20	1000x262	Amber	15.750, 60	Also available in green, #115
20	1000 (H)	Amber	15.600, 60	Also available in green
15	640x250	Green	15.750, 60	Also available in amber, ZVM-123A
N/A	260x300	0.43	15.750, 60	Has green only switch
4	260x300	0.63	15.734, 60	
4	320 (H)	0.50	N/A	TV receiver/monitor
N/A	260x300	0.60	15.750, 60	14" screen
15	640x200	0.40	15.750, 60	14" screen
5.3*	560x230*	0.63	15.750, 60	Also has RGB inputs; TV receiver;
10	250x200	0.31	15.750, 60	
15	250 (H)	0.63	15.750, 60	10" screen
N/A	300 (H)	N/A	15.750, 60	15" screen
N/A	640x200	0.37	15.750, 60	IBM/Apple mode switch
3.8	280x300	0.65	15.734, 60	
5	340x230	N/A	15.750, 60	
N/A	480 (H)*	0.50	15.750, 60	TV receiver/monitor;
3	280x350	N/A	15.750, 60	
4	320x200	0.63	15.750, 60	
3	320 (H)	0.50	15.734, 47-60	Also has RGB inputs
4.5	260x300	N/A	15.575, 50-60	14" screen
2.5	250x240	0.68	15.750, 60	Has RGB mode with 6-MHz bandwidth
N/A	640x300	0.31	15.750, 60	
12	640x240	0.43	15.750, 60	
25	600 (H)	0.38	15.7, 60	
40	921x739	0.31	15-37, 50-60	Also accepts composite color
25	720x512	0.31	14.5-25.5, 47.0-70.0	Requires special adapter for IBM, Apple
15	640x200	0.63	15.7, N/A	
14	640x200	0.43	15.750, N/A	
25	720x400	0.31	15-19, 40-70	
8	690x240	0.31	15.750, 60	
15	640x480	0.31	15.750, 60	10" screen
15	690x480	0.31	15.750, 60	
20	690x480	0.31	31.4, 60	Noninterlaced; requires Scan Doubler, $249
18	640x240	0.43	15.750, 60	14" screen
6.2	500 (H)	N/A	15.750, 60	25" screen
18	640x240	0.41	15.750, 60	14" screen
18	720x240	0.31	15.750, 60	
7	690x240	0.31	N/A	Also has analog input
15	640x200	0.38	15.7, 60	IBM compatible.
22	640x400	0.40	26.4, 60	14" screen
25	720x400	0.31	27.70, N/A	Requires Persyst BOB board or equivalent
25	690x240	0.28	15.750, 60	
20	640x240	0.41	40 (V)	Green-screen switch

PERSONAL ROBOTS



New products offer a chance to get hands-on experience with robotics for a relatively modest cost

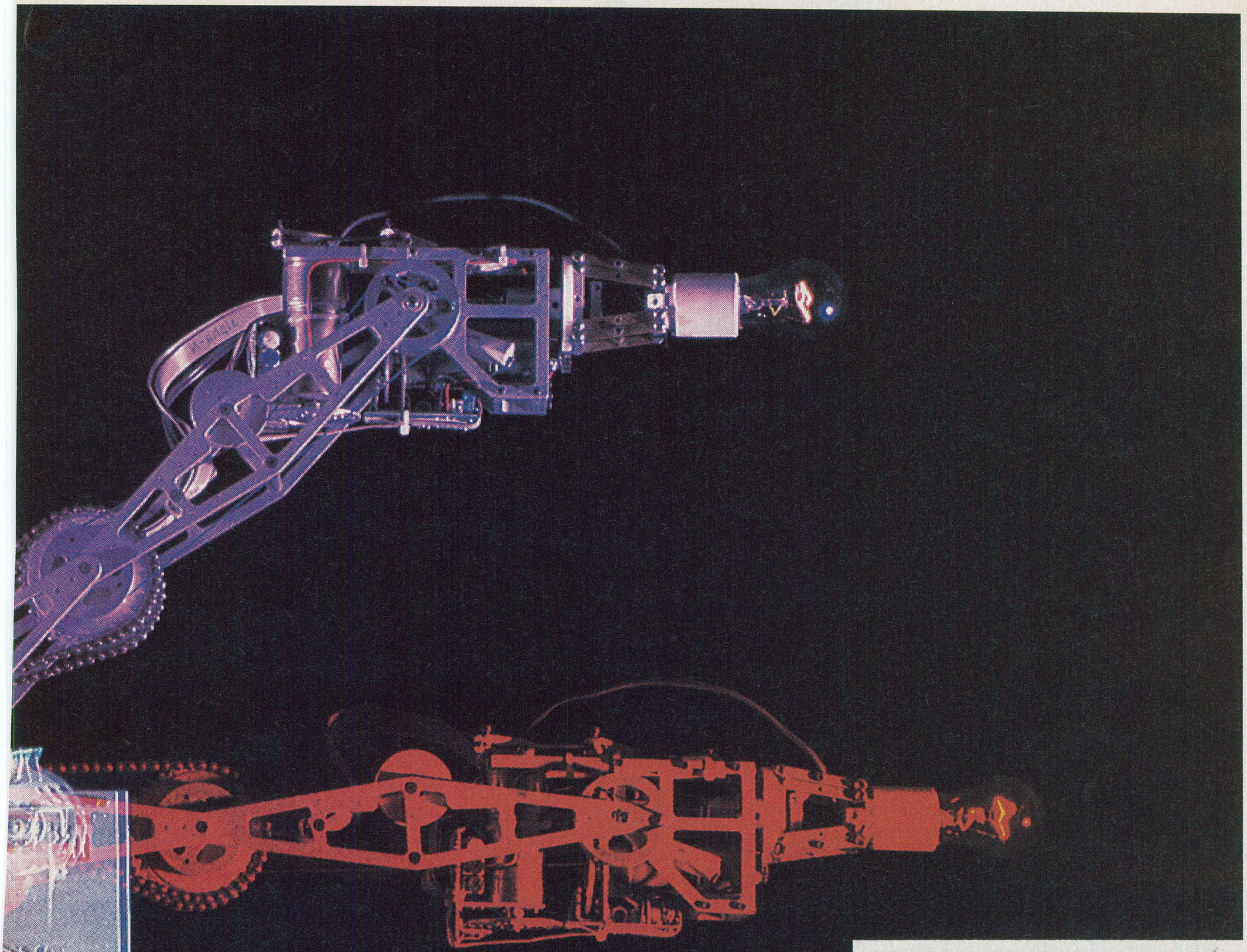
BY JOHN CONWAY

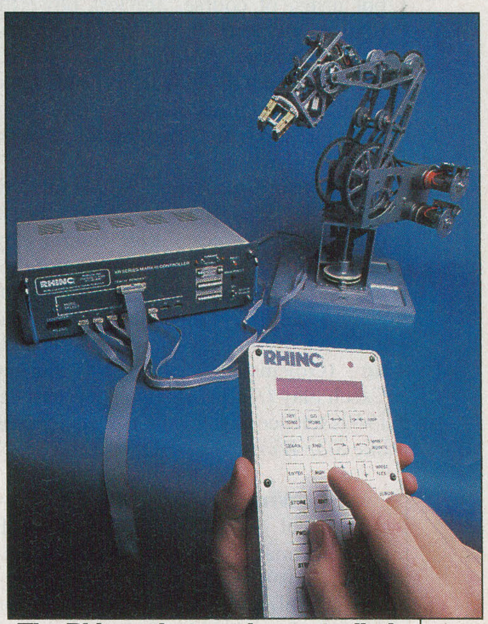
ROBOTS, as any Japanese car manufacturer knows, can be much more than just intelligent toys. They have evolved into productive, efficient machines that are altering the nature of work and the role of humans in the workplace. And now robots are beginning to enter the home. It is the first wave of an invasion that might have as much commercial importance as the popularity of personal computers.

"The personal robot industry is here and will be much, much bigger than the personal computer industry," claims Nolan Bushnell, the former Atari chairman who now heads the robot manufacturer, Androbot. "The personal robot industry will someday equal the automobile industry," according to technology guru Carl Helmers.

Turtles, Arms, Mobiles

There are three varieties of personal robots rolling into living rooms. We will





The Rhino robot can be controlled by keypad or personal computer.

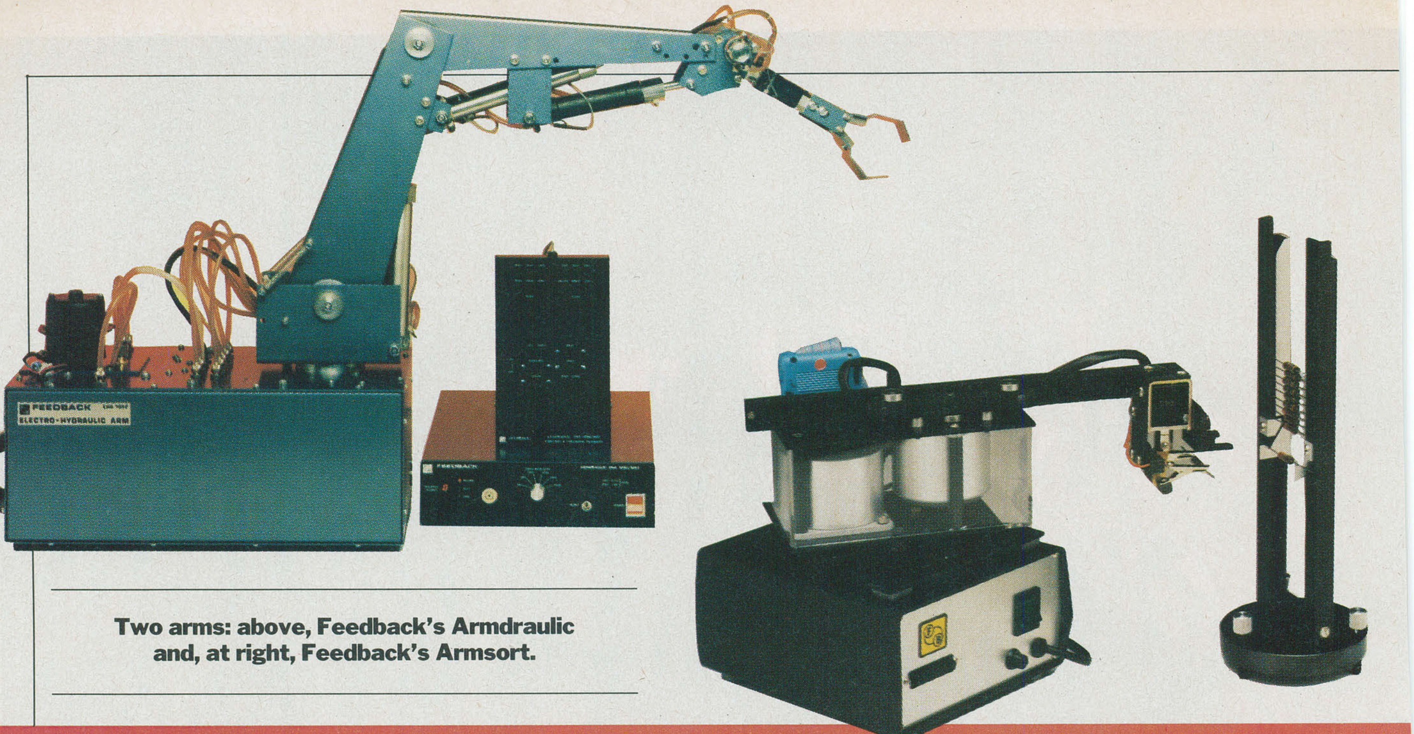
look at each kind separately: turtles, arms and mobiles.

Turtles are small armless boxes, typically less than 6″ long, usually tethered to home computers. They move on wheels, emit sounds and have touch and vision sensors. Turtles are usually equipped with pens or other drawing apparatus for executing graphics commands.

They trace their ancestry to pioneering work done at MIT in the LOGO computer language. LOGO utilizes the image of a turtle as the video screen "cursor" or position marker. Advanced LOGO versions use robot turtles as outboard graphics plotters. For this application, the turtle is fitted with a felt-tip pen which the robot can raise or lower under computer control. Thus, as a LOGO user constructs a graphics image on the video screen, the remote turtle reproduces that image as a drawing on newsprint or typing paper.

John Conway is manager of the Technical Computing Group at Theodore Barry and Associates, a management consulting firm in Los Angeles.

PHOTO BY AL SATTERWHITE



Two arms: above, Feedback's Armdraulic and, at right, Feedback's Armsort.

More than a half-dozen companies manufacture turtles, for prices ranging from a few hundred dollars to a thousand. Some, with their own microcomputers, run free of cords and do not rely on separate computers.

Arms are personal robots that have descended from early industrial machines for manipulating nuclear or submersed material; they are cousins to such current industrial robots as automated welders and numerically controlled (NC) machine tools. Personal robot arms, of course, are less powerful than more costly industrial machines. Although some of the newer products are suited to light industrial tasks, most arms are used in technical classrooms as training aids for programmers and operators.

Mobiles are what most people think of when they hear the word robot. These mechanical devices mimic humans by replicating such obvious human functions as motion, speech, manipulation and vision. They have been anticipated in Greek mythology, ancient Judaic culture (Golems), an early 20th-century Czech play *(RUR)*, Buck Rogers serials, 1950s science fiction, and futuristic films like *Star Wars*.

Who Will Buy Them

Personal robots are popular with three primary groups: toy/entertainment consumers, technical hobbyists and school/home educators. Sales for the years from 1985 to 1990, as projected by Capital Funding Associates (CFA), a Pittsburgh-based venture firm, will be greatest in the toy/entertainment segment.

"High-quality, big-ticket toy systems will experience fast growth over the next five years. Remote control airplanes, cars and robots are natural entrants in this area," CFA president John Hazlett claims. He also predicts that toy robots alone could generate more than $200 million in annual revenues by 1988-1990.

Perhaps it was the promise of massive sales that led the Ideal Toy division of CBS Toys to introduce their first microcomputer-based consumer robot, Maxx Steele. David Berko, product manager for the under-$300 toy, explains, "Robotics is definitely a part of the future. Though I'd be the first to admit that nothing is certain in this business, I'm confident that robot toys will be with us for a good long time . . . and that the market will be a healthy one."

Technical hobbyists comprise the next largest group of potential buyers, up to one million upper-middle to high-income individuals, many with engineering degrees. Seeking the latest in technology, they are the people who helped found solid-state ham radio, hi-fi, and stereo. They were the first to own personal computers, home videos and satellite dishes. Analysts believe that these technical hobbyists are waiting to receive the products from the personal robotics revolution. Robotics author David Heiserman agrees. He estimates that soon one million hobbyists will each spend $300 to $400 per year on robots.

Nobody appears to be attuned to these signals better than the Heath Division of Zenith Radio Corporation. It has sold more than 8000 HERO 1 robots, for $1250 to $2500, principally to hobbyists, and has started to offer a "stripped-down" version of its intelligent machine (HERO JR) for general hobbyists.

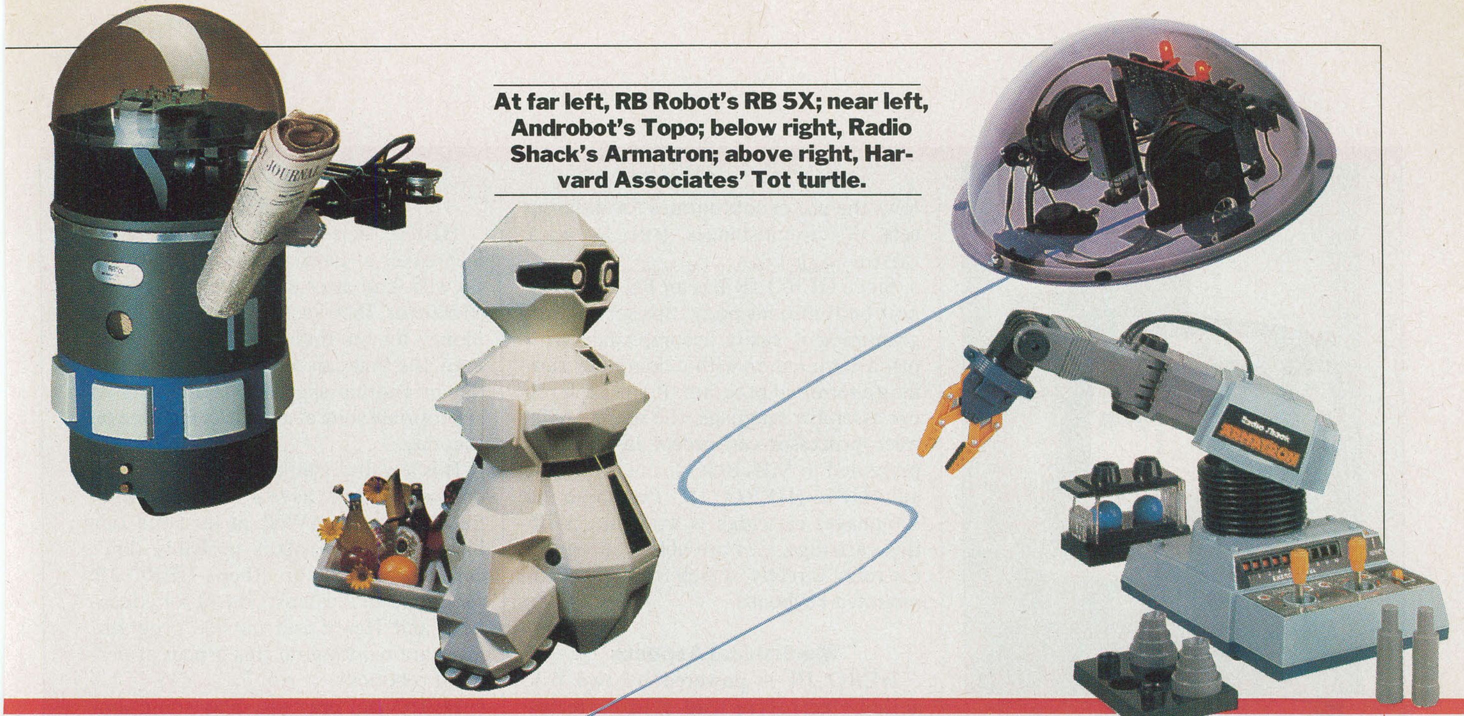
Education, the third segment of the personal robot market, is smaller but still potentially significant. Sales to educators will be sizable because teachers will need personal robots to train engineers and technicians. The Robot Institute of America, a trade group, estimates 12,000 to 15,000 people will be needed by 1990 to install industrial robots. To train them, educators who are unable to afford industrial products will turn to simple, rugged, personal systems that provide required functions at low cost. Arm-type personal robots, closest relatives to the industrials, fill this niche nicely, as Harprit Sandhu is quick to point out. Sandhu's Rhino, one of the most popular systems among educators, has generated more than $1 million revenue for Illinois-based Sandhu Machine Design. Sales prospects look bright.

In the home-education market, consumers are making LOGO and LOGO-like languages the standard for budding programmers. The turtle orientation of LOGO languages will undoubtedly boost the demand for simple and advanced turtle robots. Although the present high cost of turtle devices has deterred potential buyers, prices may fall. More than one computer peripheral manufacturer (Koala among them) is rumored to be test-marketing turtles that will retail for under $80.

What They Can and Can't Do

Despite rising sales, the question remains: Just what can you really do with these things?

One industry leader sees the robot as a close friend and companion. Another, Nolan Bushnell, views robots as the ultimate slaves. Still others think of personal robots as mobile dish and window washers. Detractors say it is all nonsense.



At far left, RB Robot's RB 5X; near left, Androbot's Topo; below right, Radio Shack's Armatron; above right, Harvard Associates' Tot turtle.

Who is right? Many observers believe that the nay-sayers may, for the present, be right. After all, how much would anyone pay for a machine that is cute but really can do little more than entertain—$25,000, $2500, $250, $25?

Let's examine a few of the issues that may determine the acceptance of personal robots.

Mobility: Robots have trouble getting around. Anyone who has set up electric trains on the living room rug can appreciate that wheels often get ensnarled in carpets. Tank treads work well in a variety of terrains, but cannot negotiate even a few stairs. Installing legs on robots seems an obvious solution, but one that requires complex gearing and balance mechanisms.

Power Sources: Robots consume energy at tremendous rates. The size, weight and energy density of most batteries place severe constraints on robot designers. This problem, also faced by designers of electric automobiles, may some day be solved, but not before much R&D time and money are spent.

Artificial Intelligence: The void that separates the brain-power of an R2D2 or C3P0 and the present state of the robot art could contain several galaxies. This is not to say that the industry must wait eons before low-cost robotic intelligence becomes available. "Geometric redesign," the ability of advanced computers to design systems one generation ahead of themselves, which in turn design systems one step beyond themselves, and so on, could lead to exponential computer chip development cycles. Nevertheless, we still have long way to go.

Looking to the Future

Artificial vision, speech recognition, manual dexterity, navigation are just a few areas where robots may aid humans someday. Last spring, the first personal robotics convention, in Albuquerque, NM, was attended by more than 3000 people. Of these, 400 students, business people and educators paid $200 admission fees to hold a separate rap session.

They concluded that the robotics market is just being born. No one can say with any certainty how large it will grow or how quickly. The potentials of the personal robot exceed those of the personal computer by as much as several orders of magnitude, they agreed. What is a robot anyway but the ultimate personal computer? However, these potentials will not appear overnight. Thousands of breakthroughs will be necessary to produce the ultimate automaton. Technologically, today's personal robot has the same relationship to its future as the Wright Flyer had to the starship Enterprise. ◇

For a list of turtles, arms, and mobiles, turn to page 88.

HERO JR.

BY JOSEF BERNARD

WHAT'S 19" tall, likes to go exploring, and sings the Dr. Pepper jingle? Why, it's the Heath Company's new robot, HERO JR.

HERO JR is Heath's second-generation robot, patterned after HERO 1, who was featured on the cover of C&E in January 1983.

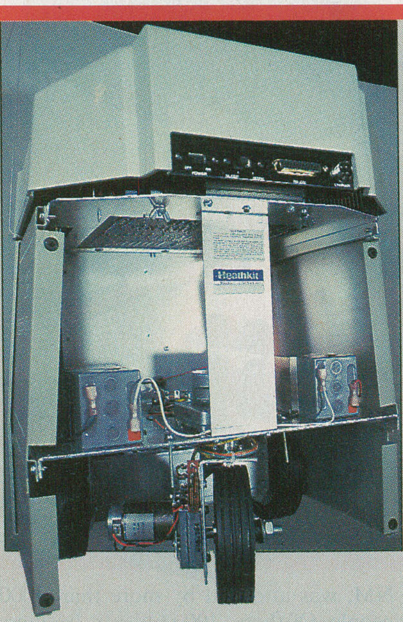
When Heath introduced HERO 1, the company told us about all the things he could do. The catch was that *you* had to program him yourself to do them. HERO JR comes with 32K of ROM (and accepts plug-in ROM cartridges) and right out of the box does almost everything HERO 1 can, and a number of other things he can't.

Personality

This new robot has a personality comprising six traits—Speak, Sing, Play, Gab, Poet, and Explore—whose levels are user-programmable: You can have anything from a garrulous robot who prefers to remain sedentary to a hyperactive but taciturn one.

HERO JR is programmed to speak, sing, gab (utter English-like nonsense words), recite poetry, play games and act as an alarm clock and sentry. You call up these activities from a 17-key keypad built into his head. His most interesting mode is Explore, wherein he roams around on his own without supervision, avoiding most obstacles (if he does bump

SIDEBAR PHOTO BY STEVE BORNS



HERO JR's driving wheel can swivel a full 360 degrees.

into something, he generally exclaims, "How did *this* get here?" or "Excuse me.") but seeking out human company through an infrared sensor or ultrasonic motion detector.

One of HERO JR's more interesting functions is to patrol your premises as a guard robot. If he detects an intruder through any of his sensors, he'll ask for a password. If he doesn't hear what he's been programmed for, he will announce that he's summoned the police. And he can, too. He can be equipped with an internal transmitter that will activate a Heath alarm system that, in turn, can trigger a device that will phone the police and ask for help.

Programmability

Aside from being able to modify his personality, you can program HERO JR to do a few other things too. He has an internal 100-year clock, and you can Plan him to carry out up to 16 different sequences of events.

Also, you can program the robot using BASIC. Heath offers, as an option, a cartridge containing an 8K HERO JR BASIC, which contains such commands as FORWARD (*n* inches), RIGHT (*n* degrees), SPEAK (a given series of phonemes) as well as instructions to input to a program the values perceived by his sensors. The BASIC supports "conditionals," meaning that IF something happens, the robot will THEN take a certain course of action, ELSE he'll take a different one. The language also supports conditional branching, which allows the use of subroutines for different sets of circumstances (ON X = Y GOSUB . . .).

Since HERO JR has an RS-232 serial port built into his body, this sort of programming is easily accomplished with just a terminal or with a computer running a terminal program. If you prefer to use assembly language, the robot's 6808 microprocessor can accept instructions presented in MIKBUG format. Finally, an HJPL (HERO JR Programming Language) cartridge is available. With this cartridge, you are able to program the robot directly, which from his head-mounted keyboard.

Mechanical Aspects

HERO JR is powered by two 6-V gelled-electrolyte lead-acid batteries (two more can be added to extend the time he can go between rechargings). Under normal conditions, a single charge can keep him going 4-6 hours, depending on how active he is.

The robot runs on three rubber-rimmed wheels—two in front and one, used for both locomotion and steering, in the rear.

While he doesn't have an arm like his older brother's, HERO JR can fetch and carry in a manner of speaking. He has a tray built into his head and can carry a 10-lb load in (or on) it.

HERO JR's sensors include a light detector and an ultrasonic range-finding device developed by Polaroid. Available as an option is an infrared sensor that can respond to body heat.

When you get tired of watching HERO JR run about on his own business, you can take control him with a radio control unit and set him going about yours. Three buttons control him: FORWARD-STOP-REVERSE, RIGHT TURN, and LEFT TURN. If you give no commands for a period of time, HERO reverts to acting on his own recognizance. A fourth button on the remote control unit instantly returns control to the robot's personality.

His speech capability comes from a Votrax SC-01 speech synthesizer IC, which offers 64 phonemes (speech sounds) and four levels of inflection. While HERO JR's built-in ROM allows you only to change his and his owner's names, when you start using programming means other than the keypad, you can make him say just about anything.

The robot is light enough (21.4 lb) so that he doesn't damage anything he may bump into. You are warned, though, to keep him away from stairs.

So Now What?

HERO JR is a lot of fun (and a great icebreaker at parties). But what do you do with him after everyone goes home? $1000 (or $600 in kit form) is a lot of money for an ambulatory alarm clock, even one that can remember your birthday or another special date and sing an appropriate song at a preselected time on that day.

It is a well-documented fact that children and robots have a natural affinity for one another. (Well, at least the kids like robots; the robots probably don't care one way or the other.) HERO JR should be an ideal instrument for education, and Heath and outside programmers are working on this aspect of personal robotics.

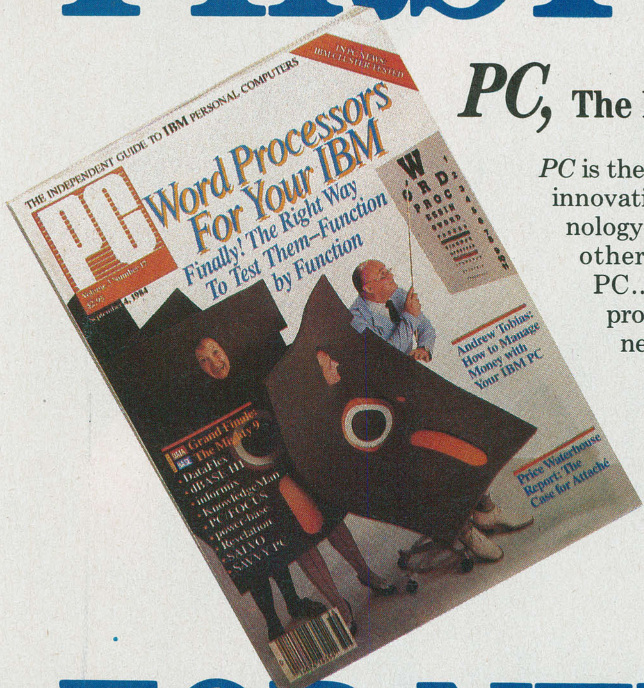
HERO can presently play some simple counting and guessing games (as well as a mean game of blackjack!) and recite nursery rhymes. More practical ROM cartridges are in the works. While the robot is no Miss Frances, he will, undoubtedly, be able to amuse and—to a degree—educate the little ones.

With schools placing increased emphasis on computers and programming, HERO JR will become a useful teaching aid. After all, if you were a kid which would *you* rather do—write a program to find the first 1024 prime numbers or one that caused your robot to scare your kid brother into jumping three feet into the air? (The latter is referred to by educators as "learning reinforcement." Kid brother probably has another name for it.)

All told, while HERO JR may look and sometimes act like an expensive toy, with a little of your imagination he can become a useful part of the household. He won't do dishes or wash windows, but he'll keep the kids amused and teach them a thing or two in the process. ◇

Top view of HERO JR showing LEDs and keypad.

FIRST CHOICE



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DATA COMPRESSION TECHNIQUES

Using easily understood principles of coding and information theory, you can reduce the space your data takes by at least 40%

BY MICHAEL McCARTHY

How would you like to nearly double the effective ASCII file storage capacity of your archive media, without hardware modifications, and *without having to pay for the required software*?

Or, if you send ASCII files between machines by modem, how would you like to cut transmission times almost in half? Again, *for free*!

Are you interested?

Of course you are. At least for CP/M and MS-DOS, programs that are currently available in the public domain will let you accomplish these things. For other operating systems you can purchase such programs as Documax for the Apple.

If you're using CP/M or MS-DOS and want the benefits of this software but don't care about the underlying technology, all you need to do is ask your neighborhood CP/M or MS-DOS expert how you can get copies of:

SQ.COM (which compresses an ASCII file to about 60% of its original size) and USQ.COM (which recreates the original file from its compressed version).

Then ask about:

LU.COM (which gathers several files into a single library file to save more disk space),

LRUN.COM (which fetches a .COM file from a library and runs it),

LTYPE.COM (which types a [compressed] library text file).

But read on if you want to understand something about the way these programs work, how they were developed, and what are some novel applications of the ideas that underlie them.

What is Data Compression?

Data compression is a way of storing information so that it takes up much less space than it would using standard storage techniques. Because the data takes up less space, transmitting it from one place to another can also save time.

The benefit is more data capacity per unit of physical storage (or more data transmitted per unit time). However, there being no such thing as a free lunch, there are technical prices to pay.

First, because the storage techniques are nonstandard, hardly any applications or utilities are able to cope with compressed data. So you need utilities to convert data, not only from standard to compressed form, but also back again. In addition, running these utilities takes time.

Second, compressed data is less reliable than standard data: Imagine that you have an ordinary ASCII file. If a single bit in the file goes bad, then an occurrence of the letter "c", say, might be changed to the letter "b." With the effect of a typo, the error often can be harmless (assuming that your operating system will continue to let you access the file).

The corresponding error in a compressed version of the same file would be a disaster. As you will see later, the damage would alter not only the "garbaged" letter but also every letter after it, in such a way that only an expert could reclaim it. But first let's explore what data compression is.

Michael McCarthy is a computer consultant and software designer.

F U Cn Rd Ths

Cn y ndrstnd ths prgrph F crs y can Thts bcs y dnt nd vwls r spcl chrctrs t ndrstnd wrttn Nglsh

(Can you understand this paragraph? Of course you can. That's because you don't need vowels or special characters to understand written English.)

Notice that by eliminating the vowels we have reduced the text to about 70% of its original size. The italic paragraph is an example of a (crude) data compression scheme.

It works because most of the information in written English (or any written European language) is carried by the consonants. The vowels and punctuation add very little to the information content. They are in most cases nearly "redundant" and dispensable. All data compression schemes eliminate some kind of redundancy.

The compression procedure we used above was very simple:

1. Get the next character.
2. If the character is a space, keep it.
3. If the character belongs to the set a,e,i,o,u, discard it.
4. If the character is nonalphabetic, discard it.
5. If the character is anything else, keep it.

PHOTO BY RICK BARRICK

THEORY MEETS PRACTICALITY

For any given language, statistical analysis can show how frequently each letter appears.

Here is Abraham Lincoln's "Gettysburg Address" without spaces or punctuation:

```
FOURSCOREANDSEVENYEARSAGOOURFATHERSBROUGHTFORTHONTHISC
ONTINENTANEWNATIONCONCEIVEDINLIBERTYANDDEDICATEDTOTHEP
ROPOSITIONTHATALLMENARECREATEDEQUALNOWWEAREENGAGEDINAG
REATCIVILWARTESTINGWHETHERTHATNATIONORANYNATIONSOCONCE
IVEDANDSODEDICATEDCANLTBATTLEFIELDOFTHATWARWEHAVECOMET
ODEDICATEAPORTIONOFTHATFIELDASAFINALRESTINGPLACEFORTHO
SEWHOHEREHEIRLIVESTHATTHANMTLIVEITISALTOGETHERFITTINGA
NDPROPERTHATWESHOULDDOTHISBUTINALARGERSENSEWECANNOTDED
ICATEWECANNOTCONSECRATEWECANNOTHALLOWTHISGROUNDTHEBRAV
EMENLIVINGANDDEADWHOSTRUGGLEDHEREHAVECONSECRATEDITFARA
BOVEOURPOORPOWERTOADDORDETRACTTHEWORLDWILLLITTLENOTENO
RLONGREMEMBERWHATWESAYHEREBUTITCANNEVERFORGETWHATTHEYD
IDHEREITISFORUSTHELIVINGRATHERTOBEDEDICATEDHERETOTHEUN
FINISHEDWORKWHICHTHEYWHOFOUGHTHEREHAVETHUSFARSONOBLYAD
VANCEDITISRATHERFORUSTOBEHEREDEDICATEDTOTHEGREATTASKRE
MAININGBEFOREUSTHATFROMTHESEHONOREDDEADWETAKEINCREASED
DEVOTIONTOTHATCAUSEFORWHICHTHEYGAVETHELASTFULLMEASUREO
FDEVOTIONTHATWEHEREHIGHLYRESOLVETHATTHESEDEADSHALLNOTH
AVEDIEDINVAINTHATTHISNATIONUNDERGODSHALLHAVEANEWBIRTHO
FFREEDOMANDTHATGOVERNMENTOFTHEPEOPLEBYTHEPEOPLEFORTHEP
EOPLESHALLNOTPERISHFROMTHEEARTH
```

It is presented here in this unusual form so that we can consider it as just a group of 1149 letters in written English. Examining this sample of the language, we can determine how frequently each letter of the alphabet is used. Since, for statistical purposes, it is a rather small sample, we shall also compare our results with figures obtained from a sample about ten times larger.

The results of our analysis should demonstrate that a few letters are used a great percentage of the time, while the balance occur relatively infrequently. It is on this premise that the techniques for data compression are based.

Letter	Large-Sample Frequency (%)	Gettysburg Frequency (%)	Gettysburg Occurrences
E	12.5	14.4	165
T	9.25	11.0	126
A	8.05	8.9	102
O	7.6	8.1	93
I	7.29	5.9	68
N	7.21	6.7	77
S	6.55	3.8	44
R	6.13	6.9	79
H	5.42	7.0	80
L	4.14	3.7	42
D	3.97	5.0	58
C	3.10	2.7	31
U	2.72	1.8	21
M	2.57	1.1	13
F	2.31	2.4	27
P	2.02	1.3	15
G	1.95	2.4	28
W	1.88	2.4	28
Y	1.72	0.9	10
B	1.53	1.2	14
V	1.00	2.1	24
K	0.66	0.3	3
X	0.20	0	0
J	0.16	0	0
Q	0.11	0.1	1
Z	0.10	0	0

While the results from the two samples do not display a precise one-to-one correspondence, they agree remarkably well. With larger samples there would be an even closer agreement. Our analysis of Lincoln's address provides an interesting empirical validation of Pareto's law. ◇

This "compression" procedure is easily programmed. However, no one today knows how to program a computer to perform the corresponding "decompression." We humans simply don't know how to express what the rules are, even though we use them intuitively.

For example, take the "nd" in the phrase "dnt nd vwls." Must the "nd" represent "need?" Could it be "and?" Could it have been an abbreviation for "industrial?" How about "nod" or "node" or "nude?"

You know that the word must have been "need" because only this reconstruction fits the context—but no program today could have made that judgment because no program truly understands English (even though some very smart people have been working on this kind of problem for more than 30 years).

The result is that for a computer environment we are going to need a different method, one that can be programmed for decompression as well as for compression. The compression procedure will have to identify redundancy and eliminate it. The procedure for reconstruction will have to be able to regenerate the original text precisely. Neither procedure will be permitted to rely on more than superficial knowledge of natural languages. We need to find a technique that compresses while it retains the full original text, character-for-character.

As you will see, we will end up with an outline design for a utility program that accomplishes our goal while offering a compression of 40-50%. Best of all, the utility that does it exists and is free, at least for CP/M and MS-DOS systems. (It's the SQ, for "SQueezer," utility mentioned earlier.)

(Continued on page 85)

THE MORSE CODE

CHARACTERS are arranged in order of decreasing frequency of appearance. Note how the code becomes more complex for the lesser-used letters. (It takes 3 times longer to send a dash than it does a dot.)

```
E .        U .._
T _        P .__.
R ._.      M __
I ..       Y _.__
N _.       G __.
O ___      W .__
A ._       V ..._
S ...      B _...
D _..      X _.._
L ._..     K _._
C _._.     Q __._
H ....     J .___
F .._.     Z __..
```

TANDY GOES COMPATIBLE

The Model 1000 offers IBM compatibility and more at a breakthrough price

BY KERRY LEICHTMAN

For those who cannot afford to say, "Price be damned, buy an IBM PC," the Tandy Corporation has a less costly answer: the Tandy 1000. Tandy, which offers more models of personal computers than anyone in the business, has unveiled its new, moderately priced MS-DOS personal computer. It costs 34% less than a comparably equipped IBM PC. In a basic configuration with two disk drives, 256K of RAM, a color graphics board and monitor, printer port, joystick port, MS-DOS and BASIC, the IBM PC would cost about $3578. The Tandy, on the other hand, 1000 would cost $2348.

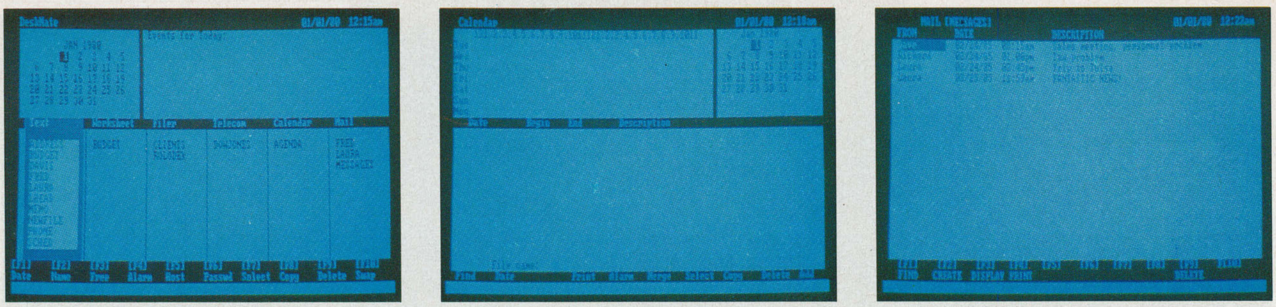
Although the Tandy 1000 represents a price breakthrough, it is not a radically innovative machine technically. At the heart of the Tandy 1000 is the venerable Intel 8088 microprocessor, the very same chip that drives the IBM PC. The Tandy 1000 offers familiar features and runs the popular software: Lotus 1-2-3, Microsoft's Flight Simulator, Multiplan and the PFS software series, among others. It also employs MS-DOS, the same operating system used by the IBM PC.

The Tandy 1000 comes with 128K of RAM, expandable to 640K, and offers a double-sided, double-density 5¼" disk drive with 360K capacity. Its monochrome and color adapters provide 640 × 200 resolution. The Tandy keyboard is detachable and has 90 keys with a numeric keypad (same as the Tandy 2000). There are a built-in speaker and audio output jack, parallel printer interface that supports IBM and Tandy printers, two joystick ports that are compatible with PC software and Color Computer hardware, and a light pen interface that is software compatible with the IBM PC*jr*. The Tandy 1000 has three PC-compatible expansion bus slots with maximum board length of 10". The machine is bundled with MS-DOS and Microsoft GW-BASIC as well as Tandy's Deskmate integrated software.

In my view, one of Tandy's major achievements with the Model 1000 is a significant reduction of what I call "feature shock." Feature shock is worse and, in fact, the cause of what Lee Iacocca calls "sticker shock." Here's how it happens: You enter a computer store and tell the clerk you'd like to buy a computer. If you're a beginner, feature shock will not be as devastating as it is to the

Kerry Leichtman, who edited Color Computer *magazine, has been following Radio Shack computers for many years.*

PHOTO BY TOM RYAN



Typical DeskMate screens, left to right: main menu, calendar, and mail.

brand changer. Buying a micro is like buying an American car—everything is extra. Whether you leave the store with or without a computer, you are certain to feel ripped off. No matter how much you think a PC costs, the price you will actually pay for a "usable" PC will be much, much higher.

If you leave a computer store without shouting abuses at the salesperson, you will have performed a miracle. If you actually buy a computer, you are either wealthy, in need of a substantial write-off, or have decided to give up on Christmas for the next five years. That's feature shock.

It is a contradiction to say that the Tandy 1000 is a nearly perfect emulation of the IBM PC and then say the 1000 is a better computer. A true clone should, by all accounts, be a mirror image. It's like saying that Jack and John are identical twins, but Jack is handsomer. It would be safer to say that Jack and John can wear the same clothes, but they fit Jack better.

Although compatibility with the PC*jr* was not a major goal of the Tandy 1000, Tandy engineers sought to achieve this compatibility wherever possible. The 1000 is able to run many PC*jr* programs, and in most cases it will run them at twice the speed (which can get pretty funny on sound routines).

Most IBM PC software allows you the option to run monochrome or color. Programs that will only run on PC monochrome machines will not work on the 1000.

In addition to the hardware features mentioned as standard with the 1000, Tandy has bundled two software disks into the package: MS-DOS version 2.1 and a program called DeskMate.

DeskMate

DeskMate is a Tandy-produced program that integrates a word processor, spreadsheet, database manager, calendar, communications program, and mail system. Each program mode has common features and fairly powerful functions. Depending on your level of need, the modes will either be sufficient or provide you with an excellent opportunity to become familiar with the workings of a program so that you can be more knowledgeable when spending money.

At boot-up, after entering the time and date, DeskMate opens with a window-like screen showing a calendar page at the top left, a listing of events of the day at the top right, a directory for each mode on the screen's center, and function key definitions at the bottom.

The main menu is cursor-driven by way of arrow keys. This picture provides the ease of mouse operation without making it necessary to move your hands from the keyboard. To enter the Text mode, for example, you only need to place the cursor over the blank space beneath the word "Text" to open a new file or over the file name to re-enter an existing file. The arrow keys, are clustered together between the enter key and number keypad on the bottom-right side of the keyboard.

When each program mode is entered, the on-screen labels for the function keys change. Commands common from mode to mode remain the same (F10 is always INSERT, for instance). Help menus are available at all times detailing all DeskMate functions.

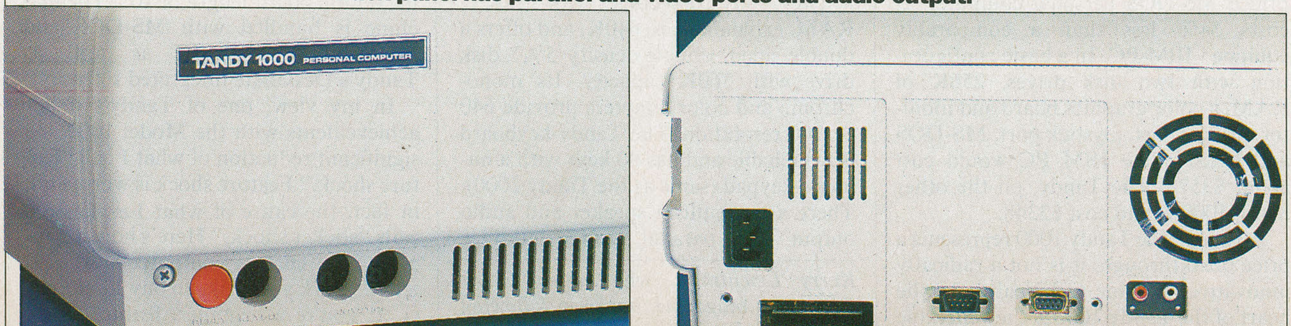
The Text mode contains more features than the limited word processor of the Model 100, but considerably fewer than Tandy's various versions of Scripsit and other full-feature word processors. Yet Text contains all the functions necessary in a light-duty word processing program. It includes wordwrap, pagination, insert, delete, block movement, margin sets, headings and footers, document merging, and nonglobal search and replace abilities. It, of course, will print on Tandy and other printers.

The DBM, called Filer, is, again, less than full featured, but very adequate. It is capable of fulfilling less sophisticated database needs: screen formatting, information searches, changing, and specific or total file listings to screen and printer. It can be performed with Filer.

Worksheet is one of the simplest spreadsheets I have seen. It is capable of a 99 × 99 work grid. Its functions include insert, copy and delete blocks; insert and delete columns and rows; define blocks for use with formulas, text or constants; and find and move other areas within the worksheet.

Telecom, very much like the telecommunications on the Model 100, can be used to log-on to database systems automatically or manually, transfer files between the 1000 and the database, and es-

Front panel has reset button and keyboard and joystick connections. Back panel has parallel and video ports and audio output.

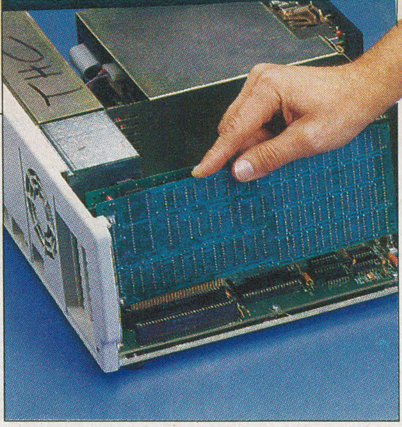


tablish personal communication parameters.

While these four modes perform their functions extremely well, the exciting (that is new) applications come via the Calendar and Mail modes.

When I described the DeskMate opening screen, I referred to the calendar page and the listing of events at the screen's top right. The information found in these two areas is entered in the Calendar mode. As in all other modes, to create a file, you place the cursor at the blank space under the directory heading. The next prompt asks for a date entry. The following screen is set up like a database manager page in that the fields are predetermined, with spaces for time beginning, time ending, and time slot description. As you fill the spaces in, a day calendar at the top left of the screen

(Continued on page 80)



The 1000 can accommodate three IBM-compatible expansion boards.

THE RADIO SHACK IMAGE

RADIO SHACK/Tandy Corp., for one reason or another, receives a lot of criticism. It's difficult to understand why. In the earliest days of microcomputing, Radio Shack made a nice little machine. It had its share of problems, to be sure, but so did the Wright brothers' airplane at first. Radio Shack has consistently been an innovator since those early days of 1977 when it was neck in neck with Apple for introducing the first mass-merchandized fully functional microcomputer. It was called the TRS-80, which stood for Tandy Radio Shack-Z80. It later became known as the TRS-80 Model I.

Almost every Tandy computer since has, in some way, contributed significantly to pricing structures, product availability, and functional uses of personal computers. The Model II used 8″ drives as part of a single-component, low-cost business computer. The Model III, an upgrade of the Model I, incorporated a maximum of 48K RAM, a monochrome monitor, and two $5^1/_4$″ disk drives into a single component. It also came complete with parallel and cassette ports and an optional RS-232 port. Its only competition at the time was the Apple II, which needed multiple (and expensive) add-on cards to perform the same functions.

The year 1980 was an exceptionally good one for Tandy. As well as the Model III, it introduced the first low-cost computer that not only offered color as standard but didn't require a special (and expensive) video display monitor. Tandy also released the first of its pocket computers, which departed from all previous computers because it was manufactured by Sharp, which also marketed the unit under its own label.

Tandy and Apple, until then, were the microcomputer mass market. Price differences and marketing methods separated each corporation's target customer. Or so it seemed. Then others entered the industry and things changed. Apple, which had always held a slight lead over Tandy, began to broaden it. New computers and game systems ate into the Tandy side of the pie. But more of that later.

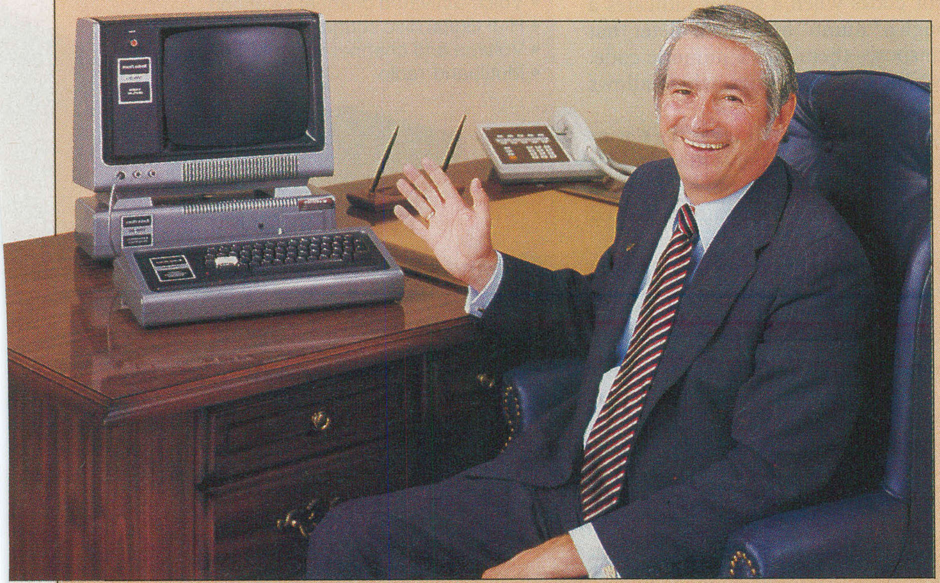
After the Model III, and the color and pocket computers, Tandy produced a few losers: the Model 12 and 16. The 12 was supposed to be an upgrade of the Model II. Instead it confused both satisfied Model II users and potential Model II customers. The 16 was supposed to be a ultra-high-powered performance machine, but it ran little software. The Model 16 has recently been transformed into the 16B. It adopted the Xenix operating system and, according to Ron Stegall, senior vice president in charge of the business computer division, "The 16B is selling well and we're the only retailer out there able to sell multi-user. Our decision to put Xenix on the 16B was unpopular two and three years ago. Not today. We have never been interested in being a me-too company."

But that's today. The models 12 and 16 meant bleak times for Tandy. The Model III and color computer were selling better than ever, but the company's reputation was slightly tarnished.

In 1983 Tandy returned to the forefront of computer innovations with the TRS-80 Model 100 portable computer. Until the Model 100, Osborne's computer was the benchmark portable. The day the 100 was introduced, the Osborne became an overweight dinosaur, a "trans" portable, or desktop computer that folded into a portable sewing machine size with a handle. In contrast, the Model 100 weighed only 7 lb and easily fit into any size briefcase. It used CMOS chip technology, operated on four AA batteries, included a built-in modem, and had a 24K ROM that contained, among other features, a word processor, a DBM and a communications program. Its 40-character by 8-line LCD display was quick and readable enough to keep complaints to a minimum and large enough to keep the Epson Notebook computer from ever becoming a serious contender

(Continued on page 79)

Tandy chairman and CEO John Roach with a TRS-80 Model I computer.



MICROPROCESSORS IN CARS

Today's automobile can be thought of as the ultimate in transportable computers

BY ALEX LEE

WHEN big-engine cars fell out of favor in the fuel-conscious 1970s, the door closed on high-performance features such as quick acceleration. However, the days of burning rubber may be making a comeback with the addition of sophisticated microelectronics under the hood. Also, with the "Pac-Man" generation, "idiot" lights on the dashboard no longer suffice; LCD speedometers and CRT trip computers are now the rage.

Most of the electronics in an automobile (and there's expected to be about $1400 worth by the end of the decade) will be linked to on-board microcomputers. In this article we take a look at some of the electronics systems that are or will soon be appearing in automobiles.

Engine Control Systems

Ford's Electronics Engine Control (EEC) IV is designed around a custom chip set from Intel Corp. that includes the 8061 microprocessor. The system, which runs at 7.5 MHz, controls engine operations and retains fault codes used for diagnostics. Fault codes are digital messages sent to the unit when one of the engine's sensors detects something amiss. These codes are kept alive in a battery-backed RAM.

Systems like this have the potential computing power to tie all the functions of the car together. Measurements such as battery charge and fluid levels will eventually be tied into diagnostic modules that will let the driver know when the car needs maintenance. For example, oil changes are usually based on mileage rather than the oil's true condition. If an acidity sensor were placed in the oil pan, an on-board memory could keep track of the car's driving characteristics, and a microprocessor could decide exactly when an oil change was needed.

Chrysler, too, has an engine control system that looks at sensor date to keep the car running properly and to store error codes when a sensor indicates a malfunction. The memory is accessed through a "dumb" hand-held meter that takes the error readings in the car and transposes them into a numeric code. These codes are stored on a data sheet distributed by Chrysler, which allows technicians to troubleshoot the engine easily.

A 6801-controlled logic module is the heart of the system. It takes the sensor data and performs an 8-bit analog-to-digital (A/D) conversion. It then decides which data should be used to govern the operation of the car and which data should be stored as fault codes in the system's 192 bytes of battery-backed CMOS RAM.

Some of the most advanced electronics are being developed for a simpler engine than the standard internal-combustion type—the diesel. For example, TRW has placed the first of three diesel modules into an Oldsmobile. This module can control the recirculation of exhaust gases; the other two will replace the mechanical fuel pump and the governing devices in the engine with their electronics equivalents.

TRW has also placed components in Ford's diesel engine for ignition regulation and trip-computer control. The ignition-regulation processor collects

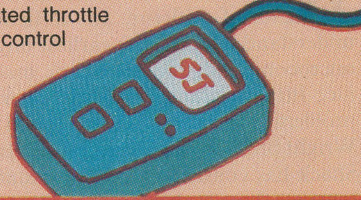
Alex Lee is a frequent contributor to this magazine on the subject of computers in industrial applications.

1 SAFETY ITEMS

- Rain-sensing windshield wiper system
- Heated windows, thermostatically controlled
- Keyless ignition to foil car thieves
- Cellular mobile telephone
- Keypad locks

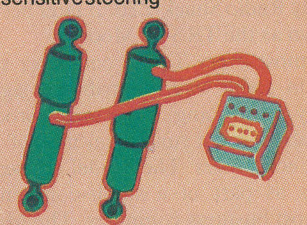
2 DRIVETRAIN CONTROLS

- Microprocessor-controlled diesel engine
- Computer-driven transmission
- No-distributor ignition
- Computerized dealership diagnostics link
- Idle speed control
- Integrated throttle
- Hybrid control of spark



3 VEHICLE SYSTEMS

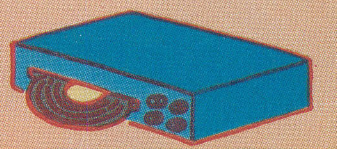
- Fiber-optic multiplexed wiring system
- Suspension monitoring
- Braking sensitive to load
- Speed-sensitive steering



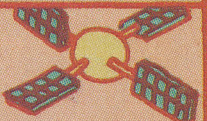
- Computer-aided ride control
- Automatic leveling
- No-lock braking
- Variable-speed accessory drive

4 AUDIO SYSTEMS

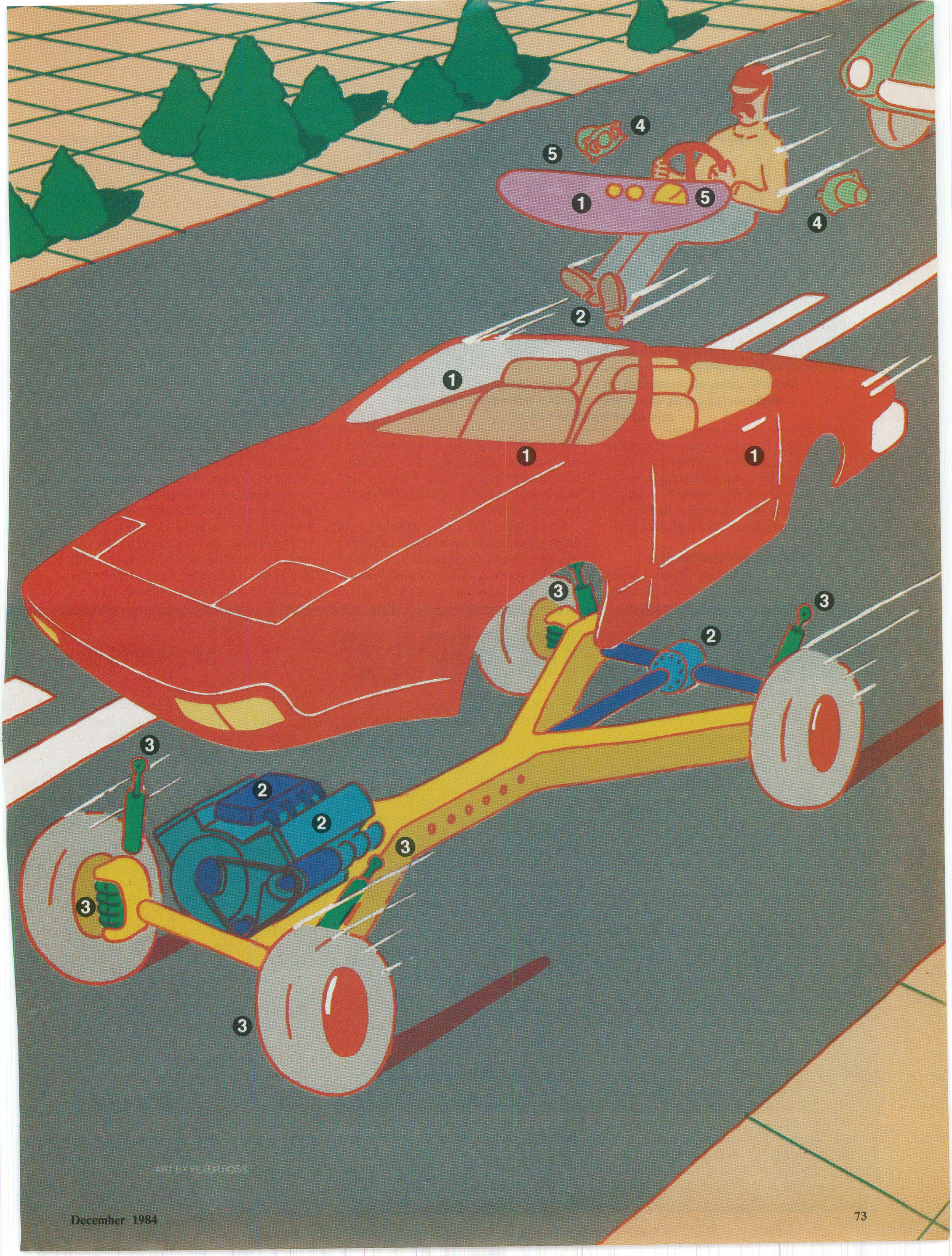
- Voice-activated channel selection
- Hi-fi digital disc sound
- Volume and channel control from rear seat
- Multiband radio



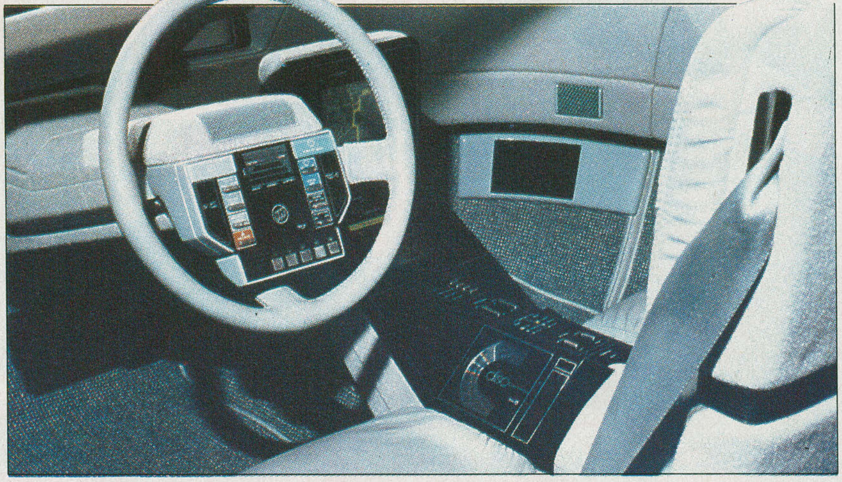
5 DRIVER AIDS



- Fuel computer
- Satellite navigation
- Service monitor
- On-board CPU with keyboard access
- Computer-aided route planner
- Real-world sensors to detect outside weather conditions



ART BY PETER ROSS



Vehicle controls mounted on steering column of concept car: road-surface traction monitor, voice-activated telephone and laser ignition "key."

information from four sensors through a 40-mA line and uses it to regulate gas recirculation. In addtion, the trip-computer processor can determine how long a fuel injection is open so that fuel economy can be displayed on a real-time basis.

Electronic Fuel Control

Electronic systems are not only being used for engine control, but also for supplanting devices like distributions and drive-trains. Electronic fuel injection and breakerless ignitions were the first step in this direction, and electronic distributors are the next.

For instance, the next generation of cars will be nearly as powerful as the big gas guzzlers of the past, but will have fewer cylinders and higher compression ratios. In order to generate a spark powerful enough to ignite the compresed gases in the cylinder, a conventional distributor would have to be very large—much larger than designers want to place into the already crammed engine compartment.

To circumvent this problem, Chrysler has designed an electronic distributor that replaces a conventional distributor and ignition coil for a future turbocharged engine. Magnetic pickups look for positional setpoints on the car's flywheel and camshaft. When these points are found, a 6801 microprocessor determines the No. 1 cylinder's top-dead-center (TDC) position along with that of the camshaft.

The electronic distributor contains two ignition coils, which fire plugs Nos. 1 and 4 and Nos. 2 and 3, alternately. Since the TDC position is always sensed, the timing never needs adjusting. In addition, because the engine is controlled electronically, just the right amount of energy is sent to the spark plugs.

The drive-train is perhaps the last system of the car that will be enhanced with electronics. Chrysler has a prototype automatic-transmission system that re-

DIGITAL AUTO REPAIR

BY PETER COSTA

It used to be that you could tune up almost any car with a volt-ohmmeter, a dwell-tachometer, a timing light and a few basic hand tools. If you were really particular and wanted to get just the right air-fuel mixture, you might also have had an exhaust gas analyzer in your tool kit. But few engine enthusiasts had that much test gear. Some Saturday mechanics, using only a $5 vacuum gauge and a trained ear, still managed to get nearly Daytona results.

But microprocessors have changed all that. In 1984, "brain boxes" control and monitor engine functions, cars making combustion more efficient but repair more difficult. By 1990, experts estimate that 9 of 10 cars will have on-board computers controlling engine functions. A recent study by the University of Michigan predicts that, by 1987, 10% of the total value of an average car and 20% of the value of luxury cars will be devoted to electronic devices.

Some mechanics are completely bewildered by digital electronics and are daunted by such things as carburetors with wires sticking out of them. In their day, mixing fuel with fire above the manifold was never done intentionally. In fact, among some older mechanics who still call electricity "juice"—as in, "the battery has a dead cell and is not putting out enough juice"—microprocessor-controlled devices are about as incomprehensible as the physics of quarks.

According to the Sun Electric Corporation, which makes auto test gear, many mechanics are "scared to death of the forest of fault trees and . . . hundreds of pages of repair manual instructions" that must be followed to make a repair. They are also frightened by the cost of replacing on-board engine computers, which Sun claims can cost as much as $700 or $800.

To help allay the service technician's anxiety and to help repair increasingly complex computer-controlled engines, auto manufacturers and several test instrument firms are making comprehensive and easy-to-use test instruments. Hamilton Test Systems of Windsor Locks, CT, sells very high-end computerized test gear, for professional mechanics, that provide hard-copy printouts of engine functions to help isolate engine problems. Hamilton's computerized engine tester electronically checks compression, secondary voltage, cylinder balance, RPM/vacuum, timing, battery load and other key engine functions via plain English prompts, eliminating the complicated test procedures usually performed with hand-held testers and "logic trees." The Sun company makes diagnostic testers that offer much of the same data but can be supplemented with a telemetry adapter. That device plugs into the on-board computer and changes vehicle signals into audio tones. The audio tones can be saved via cassette tape recorder and played back to the test computer. The data can be reviewed over and over again to help solve an intermittent problem. The Heath Company, of Benton Harbor, MI, offers hand-held test instruments as well as training courses in auto repair.

Car manufacturers themselves are building more computerized diagnostic aids into new vehicles. Chrysler, for example, uses an on-board diagnostic logic module. The module, controlled by a 6801 chip, takes data and performs an 8-bit A/D conversion. If the information derived from various sensors indicates that a section of the engine has not been performing within defined limits, the module will provide a two-digit fault code to be used later by the service technician. (See chart at right). The diagnostic module can also store intermittent

places clutches with solenoids to open transmission channels for fluid flow.

The speeds of the engine, car, and transmission turbine are recorded by an on-board computer. With this information, the computer knows just when to tell the solenoids to shift. This information is also used to adjust fuel flow during shifting so that the characteristic lurch accompanying all shifts is eliminated.

Touch Sensors

Though tooling away in the comfort of your car may be one of the most pleasurable activities of any day, the environment for some parts of your auto are far from benign. In the days of the purely mechanical and hydraulic car, brute-force engineering could be implemented to keep the parts working in the temperature extremes of the automobile, which range from -40 to $+125°C$.

Though a peice of metal or rubber may be able to withstand these conditions, a semiconductor chip is hard-pressed to take such extremes in stride. The sensing elements, which are usually exposed to the worst environments, have the roughest time and must be specially designed.

For instance, when Delco Electronics was trying to build a module that would measure manifold pressures, it could not find a sensor that would withstand the engine environment. So a unit was designed using a piece of piezoelectric silicon. Piezoelectricity is the property that causes a current to flow when the silicon is mechanically deformed and vice versa.

Touch screen controls radio, interior climate, navigation and compass. Digital map is on cassette.

When the manifold pressure changes, the silicon becomes deformed and generates a voltage proportional to the movement. The voltage is converted to digital form and sent to a microprocessor.

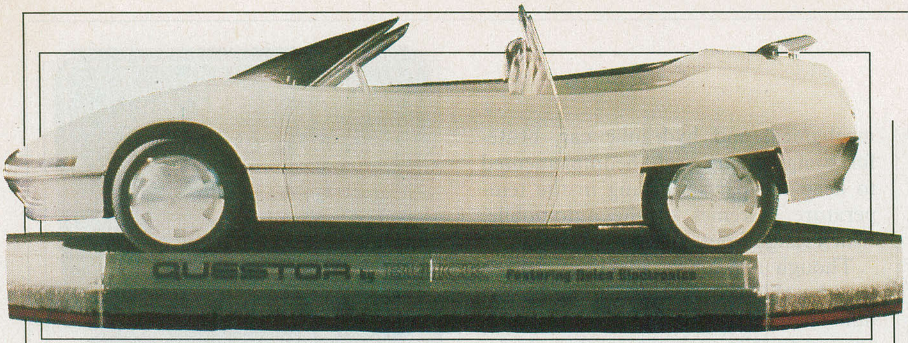
Delco-Remy, another division of

Trouble Code	Explanation
12	No distributor reference to the ECM. This code is not stored in memory and will only flash while the fault is present. Normal code with ignition "on," engine not running.
13	Oxygen sensor circuit. Engine must run up to 5 minutes at part throttle, under road load, before this code will appear.
14	Shorted coolant sensor circuit. Engine must run up to 5 minutes before code will appear.
15	Open coolant sensor circuit. Engine must run up to 5 minutes before code will appear.
21	Throttle position sensor circuit. Engine must run up to 25 seconds at specified curb idle speed before code will appear.
22*	Throttle position sensor (TPS) circuit voltage low (grounded circuit or misadjusted TPS). Engine must run 20 seconds at specified curb idle speed for code to appear.
23	M/C solenoid circuit open or grounded.
24	Vehicle speed sensor (VSS) circuit. Vehicle must operate up to 5 minutes at road speed before code will appear.
32	Barometric pressure sensor (BARO) circuit low.
34	Vacuum sensor or manifold absolute pressure (MAP) circuit. Engine must run up to 5 minutes at specified curb idle before this code will appear.
35	Idle speed control (ISC) switch circuit shorted. (Over 50% throttle for over 2 seconds.)
41	No distributor reference pulses to the ECM at specified engine vacuum. This code will store in memory.
42	Electronic spark timing (EST) bypass circuit or EST circuit grounded or open.
43	Electronic spark control (ESC) retard signal for too long a time. Causes retard in EST signal.
44	Lean exhaust indication. Engine must run up to 5 minutes in closed loop and at part throttle before code will appear.
45	Rich exhaust indication. Engine must run up to 5 minutes in closed loop and at part throttle before this code will appear.
51	Faulty or improperly installed calibration unit (PROM). It takes up to 30 seconds before this code will appear.
53*	Exhaust gas recirculation (EGR) valve vacuum sensor has seen improper EGR vacuum.
54	Shorted M/C solenoid circuit and/or faulty ECM.
55	Grounded VREF (terminal 21), high voltage on oxygen sensor circuit or ECM.

* On 1984 cars only.

problems so they can be examined later when the car is brought in for servicing.

On many U.S. cars, the logic module is located behind the "kick" panel on the passenger side of the car. Fault codes are displayed via LED. To determine the fault code the mechanic turns the ignition key on and off, on and off, then on again within 5 seconds. The LED will light for 2 seconds as a bulb check, then flash on and off. Short pauses separate flashes; longer pauses, digits. For example, 5 flashes, pause, 1 flash is read as fault code 51. Chrysler (and most other car manufacturers) also provides a digital readout box that is attached to a connector under the hood and displays codes in a digital readout. The major car makers are trying to help by offering their service people constant upgrades of their diagnostic manuals and service bulletins. AC Delco of General Motors has extensive training materials and also presents several workshops/schools on servicing at 31 training centers around the country. The courses cover everything from basic tuneups to seminars on the workings of heavy-duty trucks. And the National Institute for Automotive Service Excellence, which conducts voluntary examinations of me-



Concept car from GM, the Questor, is an electronic test bed.

Motors, was also forced to design its own knock sensor. It is basically a phonograph needle that is resonant at the frequency of a knocking cylinder. If the sensor picks up a knock, engine performance is downgraded so that the engine does not deteriorate.

Jazzing It Up

It is not the engine electronics that will catch the eye of a prospective buyer in a showroom, but the electronics that appears on the dashboard and other areas of the car's interior. Though only $250 in electronics is being spent on a car today, by 1990 that figure should jump to $1400—even as the prices of electronic devices continue to fall.

Both General Motors and Ford have built showcase cars designed to display the latest in technology. The microcomputers, has a keyless entry system, and the seat, steering column, and floor pedals automatically alters to the taste of the driver.

Ford's car, the Continental Concept 100 has much of the same, though it boasts of having "the greatest array of functioning advanced electronics ever assembled in one vehicle." The electronic features in the car include keyless entry, electronically controlled air-suspension, two entertainment centers with fiber-optic links, voice synthesis and recognition, four-wheel anti-skid brakes, satellite navigation, a four-color liquid-crystal display, and front and rear sonar detectors.

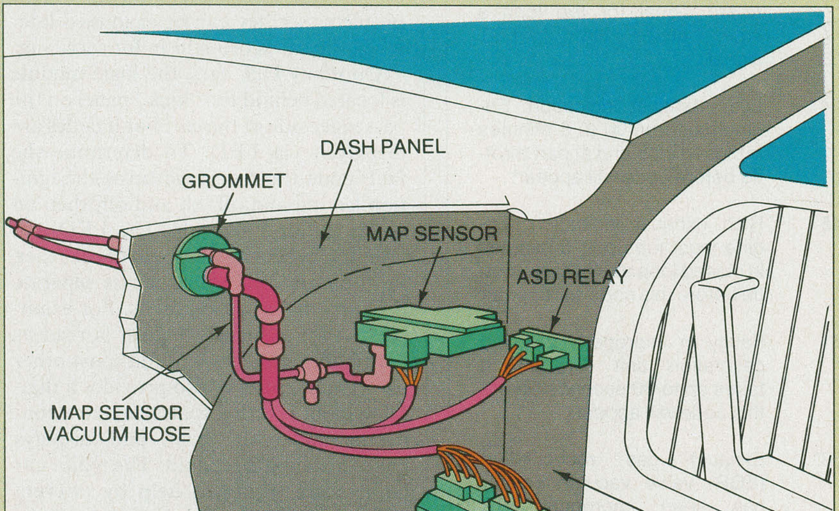
Satellite navigation is the key function of a multiple display information system called Tripmonitor, which includes a 9″ diagonal, eight-color CRT mounted in the center of the instrument panel. Through spotting satellite, the car can locate itself with an accuracy of 1200 ft; the screen then displays a regional map along with the car's location.

Because each screen requires 8K bytes of memory, different storage schemes are being explored, such as programmable read-only memory, floppy disks, and microcassettes. In addition, the CRT provides information like time, trip data, and graphic safety warnings. For instance, the graphic warning display shows a car silhouette with indicators for door ajar and low tire pressure.

Big Display

This display that the Continental Concept 100 uses is an LCD measuring 11.4″ × 4″. It shows a speedometer, odometer, trip odometer, hockey-stick-shaped tachometer, and gauges that show temperature, voltage oil-pressure,

DIGITAL AUTO REPAIR



Logic module is located behind kick panel on passenger side of automobile for easy servicing.

(Continued from page 75)

chanics, has recognized the importance of the electronic revolution in auto engines and is including more questions on their exams dealing with electronics diagnostics and repair.

But repair problems continue despite better diagnostics and training. There are many stories about mechanics who mistakenly replace entire computer modules because a sensor feeding information to the module was defective. Some inexperienced mechanics have also been known to replace $250 carburetors rather than repair defective $15 solenoids on the carburetors. But these incidents are occurring less as training becomes more widespread among dealerships and independent service stations.

And in defense of some mechanics, today's engines are about as easy to work on as the Space Shuttle. Vacuum lines cover the engine like Amazonian jungle vines, engine compartments are crammed with accessories, anti-pollution cannisters, valves and lean-burn gadgets. And as if that were not enough to make mechanics hang up their torque wrenches, V-6 engines are installed sideways on front-wheel drive cars on top of heat-producing transaxles! Ask anyone who owns a V6 Citation how "easy" it is

and fuel level with bar graphs.

Ford's advanced car also has a voice-alert feature that uses synthesized speech to tell the driver that a door is ajar, lights are on, or the trunk is open. It also warns the driver to check various fluid levels. If you don't mind talking to the car, you can tell it to raise or lower the antenna, turn the wipers on, and turn headlights on or off. The system learns the driver's voice characteristics through a training procedure and uses the stored speech patterns to distinguish a command.

A sonar detection system in the car's front and rear bumpers tells the driver of obstructions in the car's path, like a small child or tricycle in the driveway. The system can make parking easier because the driver can check the displays to determine the distance between the bumper and another car behind or ahead.

The car also has an entertainment center with front and rear consoles. Each has its own microcassette players. A CRT in the rear may be used to watch TV or play video games. In addition, a single seven-band graphic equalizer and an AM/FM stereo tuner are shared by both units, which communicate over a fiber-optic link.

You Can Find Them Today

Though you may dismiss these automotive electronic devices as futuristic marketing ploys, many exist in cars today. In fact, by 1990 you will be hard-pressed to find new cars having any other kind of display. The main reason is cost: These colorful gauges will be cheaper to manufacture than their mechanical counterparts.

But each type of display has problems. Light-emitting diodes, which are in common use today, require lots of power and are dim. Vacuum-flourescent (vf) displays and LCDs have neither of these problems but do not work at low temperatures. Vf technology may be the best bet because it has a wider operating temperature range than LCDs and can be manufactured in large volumes.

Electronic gauges will appear on the displays. However, because they must be accurate, nonvolatile and tamperproof, they are not easy to design. Chrysler's design for an odometer is typical of what

Digital readout shows oil level, other vital signs.

is needed.

A reed-switch relay attached to the car's rear wheels sends 8000 pulses/mile to a microprocessor. The latter counts these pulses and compares them with engine readings so that tire slippage can be accounted for. This information is kept in RAM until 10-kilometer increments are reached. At that point, the microprocessor downloads the data into an electronically erasable programmable ROM (EEPROM).

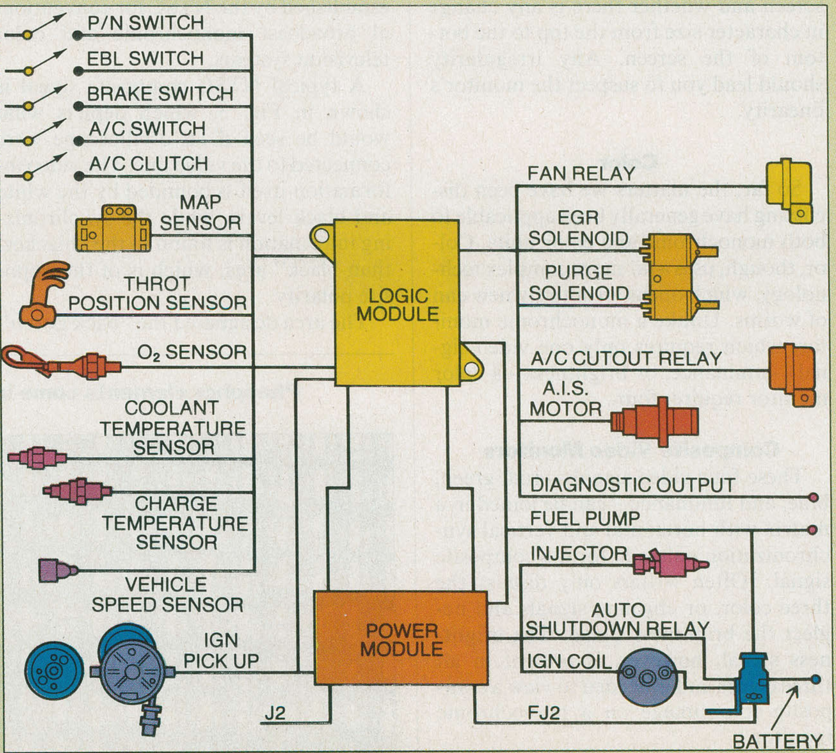
These displays will prove instrumental in providing on-board diagnostics and, along with the incorporation of voice technology, will make cars safer to drive. For instance, Audio Systems mar-

(Continued on page 87)

to change a fan belt. A fan belt change used to be a trivial job: 5 minutes, one wrench. Now with some cars it's virtually a dealer-service item. The bolts on the yoke holding the fan belt, hidden in the dark recesses of the engine compartment, often can only be reached by hoisting the car on a lift.

Troubleshooting complex electrical systems can take the average mechanic into *Star Trek* galaxies where no mechanic has gone before. Electronic fuel injection systems sometimes have service diagrams with over 150 steps requiring detailed, painstaking tests all along the way. One needs the patience of Job and the insight of Steinmetz to isolate and cure, for example, an intermittent problem in an electronically controlled vacuum servo device.

The scene in the garage is not totally bleak. Electronic ignitions that can last up to 100,000 miles need virtually no adjustment. Computer modules last even longer. So, the frequency of repairs is down dramatically. It remains to be seen, however, whether mechanics will be able to keep pace with the digital revolution and feel as comfortable replacing a PROM as they were replacing a fuel pump. ◇



Computer-controlled fuel injection system provides precise air/fuel ratio for all driving conditions.

Video Signals

(Continued from page 55)

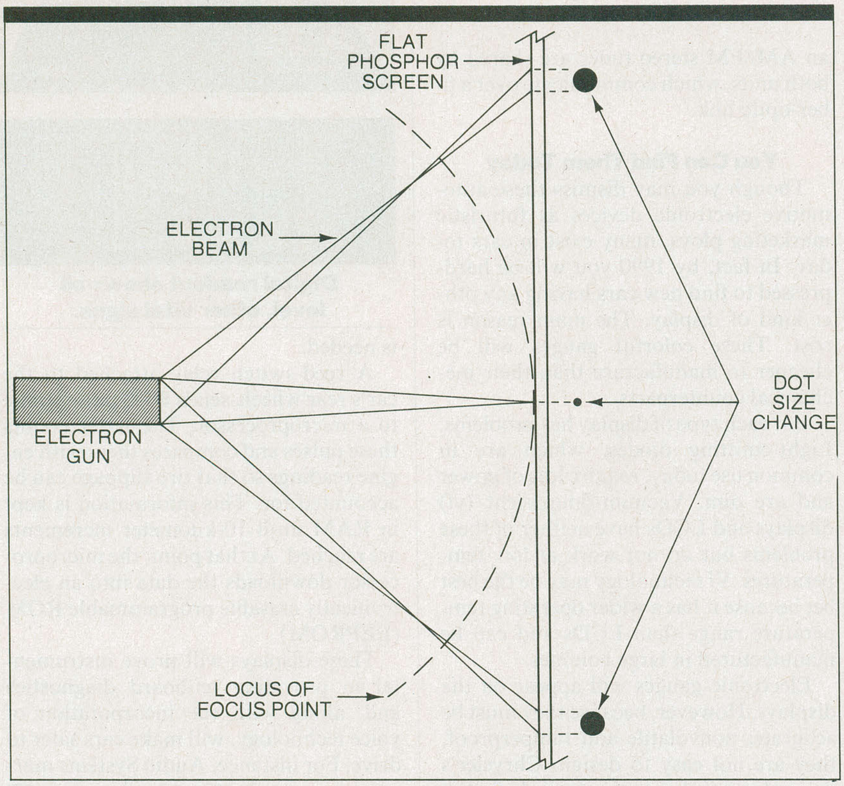


Fig. 5. Electron beam focus changes as screen is swept.

You can also use the screenful of "m"s as a test for linearity by observing how straight each line is across the screen and whether there is any change in character size from the top to the bottom of the screen. Any irregularity should lead you to suspect the monitor's linearity.

Color

So far, the matters we have been discussing have generally been applicable to both monochrome and color units. Color, though, uses a far more complex technology, which opens an entirely new can of worms. Unlike a monochrome monitor, which requires only one video signal—luminance, or brightness—a color monitor requires four.

Composite Video Monitors

These four video signals—red, green, blue, and luminance—can be joined in a matrix with horizontal and vertical synchronization pulses to form a composite signal. (Often writers only discuss the three color, or chroma, signals and neglect the brightness signal. The brightness signal, however, is present in all three colors and is needed to view a composite color image on a monochrome monitor.)

This "composite" video signal is the most common type of video signal found in monitors (and it is the only one in TV receivers). It is based on specifications established by the NTSC for conventional broadcast monochrome and color television systems.

A typical NTSC composite signal is shown in Fig. 3, which depicts what would be seen if an oscilloscope were connected to the video line. The video information itself is bounded by the white and black levels, while the synchronizing information is found in the "blacker-than-black" area, which is of the opposite polarity.

The area designated the "back porch" provides a black frame at the left edge of the displayed image, while the "front porch" provides a black frame at the right edge. Note that since the sync activity is "blacker-than black," it will not be visible. In the case of a color signal, the chroma (color) circuits' synchronizing "color burst" is located in the middle of the back porch.

Circuits within a TV receiver or composite monitor separate the four signals for processing and application to the appropriate electron guns within the color CRT. (See Fig. 4, which also gives you some idea of the difference in complexity between monochrome and color systems.)

Each stage this signal goes through to de-matrix it and otherwise process it will introduce some degradation of quality. The end result of all the little degradations can be a significant loss in image quality.

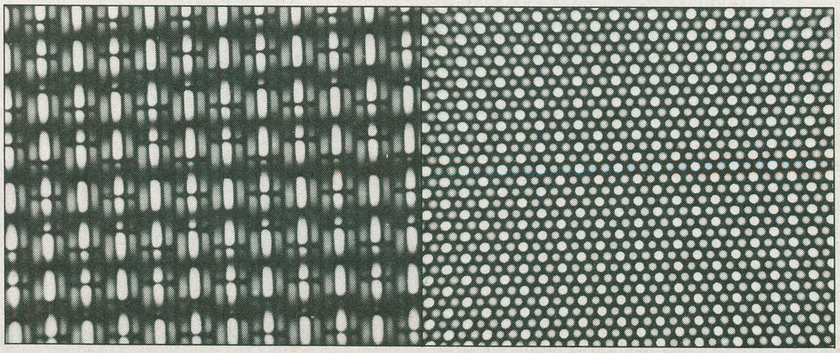
To produce a sharp color image, each of the signals must have very close timing, amplitude, and phase relationships with the others. If every component of the receiver or monitor is working as designed and intended, the result will be a "clean" video signal. However, any out-of-tolerance components, or any misalignment of the circuits, will interfere with the signal relationships and degrade image quality.

RGB Monitors

RGB monitors do not use the relatively low bandwidth composite video signal. Instead, they accept separate red, blue and green signals of rather high bandwidth. The sync pulses can also be separate, or they may be carried along with one of the color signals (usually the green).

Each of the three color signals is amplified and applied directly to the appropriate electron gun of the CRT. This almost direct feed, free from any dematrixing that could introduce errors,

Phosphor elements come in a variety of shapes and sizes.



yields a signal of higher quality.

There are two types of RGB monitors. The sort commonly used with computers can accept only logic-level signals. As a result, the brightness of a color cannot be controlled—the electron beam is either on or cut off. Normally, just three bits are used to send information from the computer to the monitor—one for each beam. Combinations of these three bits allow the generation of up to eight colors (red + green = yellow, red + green + blue = white, etc.).

The other type of RGB monitor can accept analog inputs. That is, the level of each color can be varied continuously, to produce a near infinite range of brightness levels and colors. This sort of monitor is rare in microcomputer circles, since most of the computers in use have only logic-level RGB outputs or analog composite video outputs.

Chromatic Aberration

Image quality is also affected by the design of the color CRT itself. Unlike a monochrome tube, which only uses a single electron beam, a color CRT uses three beams, one for each color. The luminance and sync signals are common to all three; the signal level to each electron gun is controlled separately.

Ideally, each electron beam excites only the phosphor (red, green or blue) associated with it and does not overlap to an adjacent phosphor element of a different color. Any such overlap will produce image misregistration, with the resulting chromatic aberration causing a reduction in the sharpness of the image.

While the three electron beams originate from what is essentially a common point, the locus of their common focus is a hemisphere centered on the center of the beam sweep. The CRT screen, however, is not hemispheric, but, rather, flat. As a result (See Fig. 5), when the electron beam trio is swept across the screen, its focus changes from sharper at the center of the CRT to less sharp at the extremes of the sweep. In a monochrome environment, this loss would simply mean poor focus, but in a color tube, the diverging beam also means that phosphors other than those intended to be excited will be. The resulting image will be blurry *and* suffer from chromatic aberration.

To ensure that each of the three electron beams strikes only its intended color phosphor, many CRTs use what is called a "shadow mask," a screen-sized sheet of metal with holes corresponding to the phosphor element positions mounted closely behind the phosphor layer. The shadow-mask holes and the paths of the electron beams are arranged so that each beam passing through a hole can impinge only on its own phosphor.

Obviously, if there is any misalignment, a phenomenon known as "misconvergence" occurs, and the wrong phosphor elements are excited. The result will be color fringing and possibly other types of chromatic aberration.

Compare the 4.2-MHz bandwidth of a TV receiver with the bandwidth of approximately 30 MHz of a good monitor, its superior convergence system, and closer-tolerance components, and you can see the superiority of a dedicated broadband monitor.

Some low-cost composite video monitors that also accept the NTSC standard 4.5-MHz FM audio signal are simply TV receivers without tuner or i-f sections, and their displays are not much (if at all) better than those of the receivers themselves.

Fortunately, the trend today is away from these "converted" receivers, which should not be confused with true monitors that have built-in baseband audio amplifiers. In the case of the latter, the audio system does not limit the bandwidth of the video section.

Sign Off

And there you have it. Not *everything* there is to know about monitors, but probably enough for you to appreciate what is going on in front of your eyes when you are using your monitor. ◇

The Radio Shack Image

(Continued from page 71)

in the marketplace.

That same year the immensely popular Model III became the CP/M- and TRS-DOS-operated Models 4 and 4p (p for portable), and the color computer was replaced by a smaller more powerful sibling that was fully compatible with its predecessor. It was called the Color Computer 2. The Tandy 2000 was also announced.

The 2000 was the first Tandy machine to appear without the Radio Shack label. It, like most Tandy computers, had many innovations. It was the first true 16-bit MS-DOS computer. It sold for half the price of an IBM PC and ran three times faster. It featured finer screen resolution, a denser disk storage structure, and Intel's highly touted 80186 CPU. The computer and business press treated it to front-page features and flashy covers. But like the Model 16 before it, the Model 2000 was released with good specs but little software. And like every Tandy machine before it, it was destined to fall prey to an antique and inappropiate marketing system. It took Tandy seven years between its first computer in 1977 and the 1984 model to learn that one cannot effectively deliver a high-tech sales pitch in a medium designed to sell 79-cent batteries.

Tandy's underserved image problem is probably more Dick Cavett's fault than anyone else's. Cavett may have been Apple's slickest move. Regardless of whether or not he sold computers for Apple, he did set the tone for how computers should be sold, or at least he established a perception of how they should be sold. On the other hand there was Tandy Corp. and its army of Radio Shack stores as numerous as McDonalds. But those neighborhood depots of batteries, wires, and radio-controlled cars just could not compete with Cavett's slick image of Izods and deck shoes. It really is strange because Radio Shack's computer product fit its inventory very well.

The executives at Tandy Corp. probably thought so too. They remained resolute and announced the latest and greatest piece of computer gear in four-color newsprint flyers. They continued to sell computers, but began to lose the image war. With profits rolling in and new competition seemingly taking more direct aim at Apple, Radio Shack sales skyrocketed. The competition had to fight for shelf space, Radio Shack didn't—they had all those stores. The competition's future depended on a one- or two-product line, Radio Shack had hundreds of items. If the computer business went bust the next day, Radio Shack would still be around while Apple and the rest would be memories. In short, Radio Shack could afford to stay out of the street fight and enjoy its success.

But with that security came short sightedness. The computer buyer began to change from the original electronic hobbyist to the general public. Radio Shack could no longer depend on its established customer base for continued growth.

What has evolved at Tandy is a much clearer awareness of the target customer. While Tandy executives remain confi-

The Radio Shack Image
(Continued from page 79)

dent of the high quality of their products and their ability to price competitively, they have taken off the blinders and adopted some new ideas about computer buyers.

David Frager, the person responsible for the TRS-80 Models 4 and 4p and Tandy 1000, states the company's idea behind selling a computer product: "We determine what kind of product is needed in the marketplace, decide what price will work, and then design a machine to fit those parameters. If it doesn't fit, most likely we won't produce the machine."

That approach is a spruced-up version of the one Tandy Chairman and CEO John Roach spoke of when he set out to have invented what became the TRS-80 Model I. Roach, a Fort Worth native, has been involved with the company's microcomputer activities from the start.

In 1975 Roach was a manufacturing executive at Tandy. Previously he had been a data processing manager. Through the company's Radio Shack stores, Tandy had been selling approximately 75 different printed circuit board kits. Roach's fascination with the capabilities of the kits was matched by that of the buyer responsible for that line of product.

During a trip to Silicon Valley to speak with people at National Semiconductor about new CB radio technology and telephones, Roach asked a few questions about computer chip technology. Steve Leininger, an NS consultant brought in to speak to Roach mentioned a nearby retail computer store called the Byte Shop.

Later that day, Roach visted the Byte Shop. It was filled with pc boards and chips. Leininger showed up at the store, the day's previous conversation was resumed, and Leininger's address and phone number were taken.

By June 76 Leininger was a Tandy employee and charged, by Roach, with coming up with a retail microcomputer. "The big problem," Roach called, "was the price seemed too high." At that point, Radio Shack had never sold anything over $500. Roach smiles at that.

Off by himself, Leininger designed and redesigned his project for about six months. "To give you an example of how we tried to keep the cost down, we decided to paint the units Mercedes silver because it was the only color you could get a halfway decent monitor in without having to pay extra. We got a paint sample from the monitor and matched the color for the computer cases."

Toward the end of 1976, a mock-up was completed.

"When we showed it to Lewis Kornfeld, who was then president of Radio Shack, we had it on a table. The boards were underneath and a reasonable facsimile of the unit was on top.

"Charles Tandy happened to drop by that day. We asked him to look at it. He just smiled and laughed." He told Roach to go ahead and build 1000 of them, explaining that maybe they'd be able to sell them, and if not, the publicity would be good. Later, to get the cost per unit down, Kornfeld approved a total production of 3000 computers.

In January 1977, Leininger began the final digital design. Roach, fearing Leininger's work would be useless without software, was not pleased with the slow progress on the part of the software contractor and doubted that the BASIC would ever be delivered. So Leininger took on the additional task of writing the BASIC. Time began to put pressure on Roach and Leininger. "Commodore was making noise about its 495 PET and speculation had TI coming in and stealing the show at any minute.

I was scared to death it wouldn't be marketable.

"By the end of June we had between 50 and 100 prototypes built. I brought one home and wrote a few game programs and such. My own quality control. And a bug showed up," Roach said. Many sleepless nights later the bug was discovered.

"I was scared to death it wouldn't be marketable," Roach remembers, "But then, in the spring of '77, we went to the West Coast Computer Faire. Thirteen thousand people paid something like $13 a head to get in. You could see all these people lined up outside the building. You get the feeling there was more than a casual interest in computers.

"After that we increased our commitment to 6000 units, and on August 3, 1977 we introduced the TRS-80 microcomputer in New York to a rather giant yawn. The media weren't interested. Someone had blown something up in New York that day, which was more interesting to them."

Nonetheless, the orders began to come in. The 6000 units went fast, Radio Shack stores were taking deposits on units that were back-ordered 60 days and more. "We'd thought we'd done something," Roach said, "We'd never had anything on back order before. My daughter and I went out to the factory one Saturday and helped put them together." He turned his chair around to face the floor-to-ceiling window in his office and pointed at a brick building in the distance just outside of the Fort Worth city limits. "That's where we made them." The 1000 is also Texas-made.

Ron Stegall takes the concept two or three step farther. Stegall places weight on what the public expects in after-sales support. To that end Tandy vows to respond quickly to customer service needs. In Fort Worth, they have doubled the number of incoming WATS lines, and correspondingly the amount of support staff answering the phones, to handle questions from Radio Shack employees. "We have to make sure our people aren't sitting on the phone waiting for help.

Customer service is Tandy's newest target area. Stegall says Radio Shack stores are so widespread that, "We'll always be the best in Pocatell, Idaho. We're working on being the best in New York and Boston.

"The customer sets the parameters of what customer service is. If 24-hour turnaround isn't good enough—and sometimes problems can't wait that long—we'll have to be able to provide while-you-wait servicing."

Although Tandy has been selling telephones for many years, it has been moving rapidly into the business phone market. Without a high-quality service and installation capability Stegall dosen't feel Tandy would have a chance. "Our computer service centers will expand with our involvement in the phone business. For computer repair we're using as a criterion the level of service needed to compete in business telephone sales." To Stegall that means easy-access repair centers, pick up and delivery of equipment, guaranteed 24-hour turn-around, and while-you-wait service whenever the customer requests it. ◇

Tandy 1000
(Continued from page 71)

blocks off (in 15-minute increments) periods of the day you have scheduled appointments for. The calendar also alerts you to conflicts of double booking by filling in exclamation points in a disputed time slot.

Back to the main menu: Because I en-

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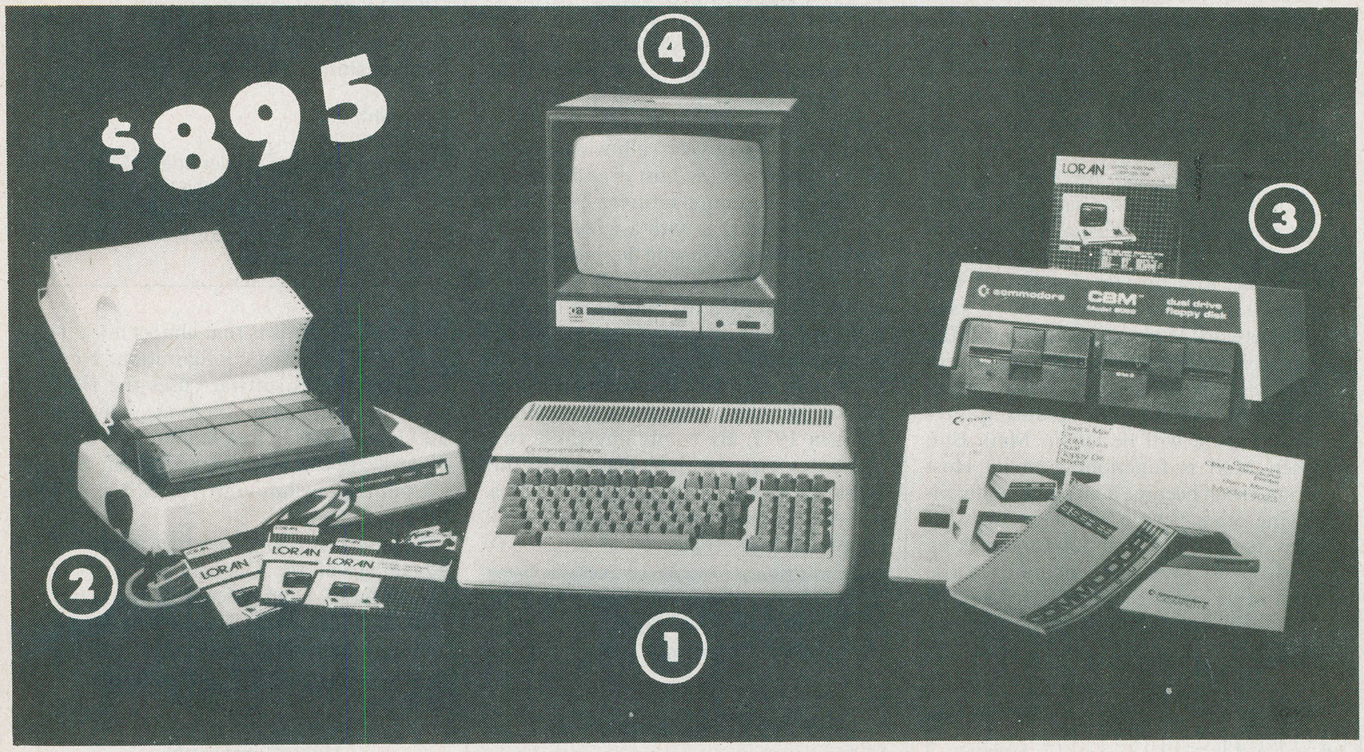

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Tandy 1000
(Continued from page 80)

tered the correct date and time when I booted DOS, the calendar automatically oriented itself to that information. So at the main menu and DeskMate opening screen, the calendar page at the top left showed the date in reverse video, and the listing of events showed all alarm appointments. As the day progressed, the calendar deleted the day's passed appointments and readied itself for the next ones.

The potential uses for time management through effective use of the calendar program are equaled by the versatility of Mail. In this mode, DeskMate has the ability to to turn the Tandy 1000 into a host station for a modem-based local area network setup. At its simplest, Mail can be used to create messages to be sent via Telecom or to store messages received. Messages picked up during automatic log-on will be left in Mail. But, when Mail is functioning in its Host mode, it can become a message center allowing other people, via their own systems, to log-on to your 1000 and pick up or drop off messages, including those from other remote users. The potential for use in interoffice, branch office-to-branch office, friend-to-friend, or within a private organization is staggering.

The Mail system is password-protectable. If Mail were set up so that a user away from a computer wanted to send notes to a home system, anyone who knew the system was live might be able to log-on and peruse the system. Because of a very flexible password system, the host user can lock others out either completely or selectively, allowing for as much privacy as the host user desires.

IBM-clone manufacturers have bombarded the market with a wide array of choices, offering varying degrees of compatibility and features. With the 1000, Tandy has chosen to compete in the PC-standard marketplace in pricing. Hardware reliability and convenient servicing have characterized the company even before the microcomputer's mass retail birth in 1977. By combining these two attributes with the right machine at the right price, Tandy may re-emerge as a powerful competitive force in the microcomputer marketplace. ◇

Princeton Graphic
(Continued from page 36)

The Scan Doubler board achieves the higher resolution by writing each horizontal line twice in succession (it does not use an interlace technique). The result is a screen display that has twice the vertical resolution and is flicker free. There are, however, still just 640 × 200 addressable dots.

Of course, the high-resolution output of the Scan Doubler would be wasted without a special high-quality monitor to send it to. This monitor is the SR-12, which operates only from the output of the Scan Doubler. The SR-12 features 0.31-mm dot pitch, a 25-kHz bandwidth, an etched black matrix CRT, and the capability of supporting 16 colors and up to 690 × 480 dots in a noninterlaced mode. The screen size is 215 mm × 160 mm.

When you add the Quadcolor II board to the system to get the optimum configuration, you can place 16 different colors on the screen at once in the high-resolution mode. Additionally, the Quadcolor II board comes with software to enhance IBM BASICA and allows you to use the normal BASICA graphics commands with the extended parameters it offers. The enhanced BASIC is called BASICQ.

Software

A problem of using the SR-12 with the Quadcolor boards is that almost no software supports this configuration. Normally, graphics software uses the IBM PC's medium-resolution mode, which is 320 × 200 dots in four colors. This kind of software can be displayed on the SR-12, but the resolution will be 320 × 400 dots.

One software program that does take advantage of the Quadcolor boards is Dr. HALO from Media Cybernetics (Takoma Park, MD). It is an icon-driven paint package that works with mouse, joystick, digitizer, touchpad, or keyboard.

Specifications

Product: SR-12 Monitor
Mfr: Princeton Graphic Systems
170 Wall St.
Princeton, NJ 08540
Dimensions: 15.3"W × 15.1"D × 11.0"H
Weight: 29 lb
Price: $799
Interface: Scan Doubler board ($249)
Features: 690 x 480 resolution, 16 colors, 25-kHz bandwidth, 0.31-mm dot pitch, etched black matrix CRT

User Comments

The SR-12 monitor, with the Scan Doubler board, provides a vast improvement over the usual IBM PC color graphics display. Images on the SR-12 are filled in completely with color with none of the grainy texture found on normal IBM PC displays. Color is bright and attractive, and with the Quadram boards 16 different colors can be integrated on the display.

Those who have been doing word processing with an IBM PC and color graphics board would appreciate the text quality of the SR-12 system, even though it falls short of the IBM monochrome display.

Conclusions

The SR-12 monitor and Scan Doubler board offer a quantum improvement over the normal IBM PC color graphics display. In order to take full advantage of the system, however, you will want to use it with the Quadcolor I and II boards. Since special software is needed to exploit this configuration, most times you'll either have to write your own or settle for less. The true power of this system won't be evident until a greater variety of software becomes available for it. Until that time the expense may not justify the results. ◇

Data Compression
(Continued from page 68)

The Development of the Concepts

Data compression is as old as the telegraph. Telegraphs that transmitted text characters electrically may first have been used in Germany quite early in the 19th century. However, a telegraph that included a complete system for the economical transmission of text messages was invented (and more important, then developed) by Samuel F. B. Morse. Morse built a whole business around the goal of message transmission. He decided to base his charges on message word counts. Then, he designed a procedure to minimize the time required to send a message. (He assumed, correctly, that the service would be very popular and would be heavily loaded, with transmission line capacity being the limiting factor.) His procedure, of course, was "Morse code."

A clever feature of Morse's code is that it exploits the letter-frequency characteristics of the English language. By and large, the most commonly used letters in English have the shortest encodements. For example, the letter "e" is used more often than any other, and it is the shortest symbol in Morse, consisting of a single "dot." In contrast, the Morse encodement of the infrequently used "q" is "dash-dash-dot-dash," which takes 13 times longer to send than the dot for "e."

Now, Morse was very clever, but he wasn't entirely scientific or mathematical in his approach. There is a better way, and he missed it. (But then, so did everybody else until around 1950.) This better way involves using a Huffman code, which generalizes and formalizes the concept of letter frequencies. It is particularly well-suited to computers.

What Data Compression Programs Do

The public domain program SQ.COM incorporates a Huffman code for shortening the number of bits required to represent text. (It also gives special treatment to repeating sequences of characters.) Overall, SQ typically is able to "squeeze out" about 40% or so of an original ASCII file.

Its decompression counterpart, USQ.COM ("USQ" for "UnSQueezer") takes files produced by SQ.COM and restores them to their original ASCII format, bit-for-bit.

Both SQ and USQ work quite well. They are easy to use; they are reliable; and their documentation is more than adequate. Their author, Dick Greenlaw, did an excellent job.

If you're tight on storage space and need SQ/USQ, then chances are excellent that you are also short of directory space and are limited in the number of files you can create (unmodified CP/M 2.2 is limited to 64 directory entries). Accordingly, you also want the LU (Library Utility) program along with its suite of related programs.

LU and its relatives allow you to package a collection of separate files into a single "library" file with its own embedded (sub)directory. The files may be compressed or not. The related programs allow you to load and execute a .COM file embedded in a library, to type a compressed library subfile, and so on. LU also has the side benefit of conserving disk space; short files waste much less space when in library files than when they are stored on an individual basis. All in all, this software is valuable, well worth tracking down.

How Data Compression Works

Suppose that we are dealing with a stream of characters represented by 8-bit bytes (which is how ASCII text is actually stored in your computer). In principle, any single byte could contain one of 256 possible values, shown here in 8-bit binary:

00000000	0
00000001	1
00000010	2
.	
.	
.	
11111110	254
11111111	255

In practice, however, ASCII files consist of text and/or numbers and/or special characters, like "$." Even counting letters twice (for upper and lower case), we get along very nicely with a total of only 96 symbols to be represented.

Indeed, a rudimentary compression scheme would simply express the 96 codes actually used not with 8 bits, but with only 7 bits (which allows for 128 possibilities).

But this method saves us only 1 bit in 8, or 12.5%. We can do better than this—much better—if we assume that we are dealing with text, because we can exploit the idea of letter frequencies.

We'll invoke Pareto's law, named after the Renaissance Italian mathematician who formulated a rule about relative frequencies of things in human events. He noticed that 80% of the revenue of a typical business tended to be generated by 20% of its customers, 80% of its inventory value was tied up in 20% of the inventory items, and so on.

Well-known as the "80/20 rule," this idea has inestimable value to business-people and managers. The philosophical importance of the 80/20 rule is that if you do a good job on 20% of the issues, you will be solving 80% of your problems. (Whence the phrase "80% solution.")

Applying Pareto's law to text compression, if we do a good job of compressing the 20% of characters that make up 80% of our text, then the overall scheme very likely will be reasonably efficient, even if no attempt is made to optimize for the relatively infrequent characters that make up the remaining 80% of the possible characters.

To a first approximation, the four most commonly encountered symbols will be, in decreasing order of frequency:

(space)	most common:
e	second:
t	third:
a	fourth:

Ignoring for the moment how to encode all the other characters, we will encode just these four, in binary, as follows:

(space)	1
e	01
t	001
a	0001

This is a variable-length code. The first bit tells us whether the symbol being represented is "space." If it isn't "space" (first bit isn't 1), then the second bit tells us whether it's "e." If it isn't "e" (second bit isn't 1), then the third bit tells us whether it's "t" . . . and so on through all the characters of interest, in order of decreasing frequency.

This code works neatly. If we assume that for English text the average word length is five characters, then every sixth character or so will be a space. Thus about 1/6, or 17%, of our characters will be represented by a single bit instead of 8 bits.

The letter "e" will not be as common as "space," but we still will require only 2 bits to express it (rather than 8), so we're still way ahead.

Now it is easy to see that we could extend this idea indefinitely, taking 5 bits for the 5th most common character, 6 bits for the 6th most common, and so on.

However, it also seems intuitively clear that, at least for English text, it would be dumb to use 9 bits to represent the 9th most common character, given that we can represent any character at all with just 8.

Evidently, at some point we need to change gears and deviate from a strict

Data Compression
(Continued from page 85)

Huffman code. In fact, let's make the changeover point 4 bits, just as outlined above. Now the encodement for anything except "space," "e," "t," or "a" will begin with 0000.

Now for a crucial trick:

After 0000, let's always use all of the next 4 bits to represent a single character. In those next 4 bits we can express 16 possible values. Let's use 15 of those 16 values to represent the 5th through 19th most common characters.

What about the 16th possible 4-bit value? We'll use it as an "escape code." Let's say that the escape code is 0000. Then whenever we see 0000 (not "space/e/t/a") followed by another 0000, we have a signal that whatever is to be represented is not one of the 19 most common characters.

How shall we represent lower-frequency characters? By Pareto's law we might as well represent such infrequent characters with their real full 8-bit codes. Such situations occur sufficiently infrequently that they are not worth optimizing.

To summarize: We use anywhere from 1 to 4 bits to represent each of the four most common characters. For any of these characters the win is big, a saving of anywhere from 4 to 7 bits (when compared to a full 8-bit ASCII code).

We use 8 bits to represent the 5th through 19th most common ones. Here there is no win, but no loss either.

Finally, we use 16 bits (0000 followed by 0000 followed by a full 8-bit code) to represent everything else. Using these, of course, is tremendously inefficient when we consider such characters by themselves. But when we look at the overall statistics, we win big (1-4 bits) much more often than we lose big (16 bits).

Now let's add one more level of complexity for dealing with repetitious sequences of a given character. Instead of using one escape code, let's use two. The first escape code has the meaning earlier described. The additional escape code is for repetition. It means: Take the next 4 bits as a count; take the 4 bits after that as a Huffman code (with the option to expand to 8 or 16 bits as necessary).

This works well for lengthy repetition sequences of the same character, typically spaces. (For short sequences it would be better to encode the spaces as a short sequence of 1's.)

The overall scheme will win only if the four most common characters drastically dominate the actual letter frequencies. Fortunately they do. In fact, the frequencies are so biased in favor of the four most common characters (or repeated spaces) that the resulting "bit stream" tends to be around half the length of the original stream of 8-bit ASCII characters.

Adaptive Encoder Program

The length will be halved for most English text, but it may not be true for other languages or for other applications (such as storing program source files). We can get around this limitation by building an "adaptive encoder" program that will work with any ASCII file.

The adaptive encoder would make two passes over the ASCII file to be compressed. During the first pass it would read the file, building a table of the 256 possible ASCII byte values and counting the number of times each value occurred in the original ASCII file.

The encoder then would select the four most common values and assign them to the four variable-length codes. The next 14 characters that appeared most frequently would be assigned to the set of 8-bit codes. Finally, all the remaining characters would be assigned to the set of 16-bit codes.

Armed with the actual frequency of occurrence of each character, during the second pass the encoder would create its output file, making the substitutions decided upon at the end of the first pass.

Note that the file doesn't have to be English text. It could be any language. For that matter, it could even be business data consisting mostly of spaces and numbers. The adaptive encoder will simply observe the relative frequencies of the various characters and decide on the most efficient encoding scheme.

All that matters is that the distribution of character occurrences be highly "skewed," with a few characters drastically outweighing all of the others in frequency of occurrence.

The decoding (decompression) process is equally straightforward. The only complication is that the decoder must agree with the encoder as to the meaning of each of the symbol types (variable-length, 8-bit, 16-bit). This agreement is reached by having the encoder record its substitution table at the front of the encoder's output file. The decoder reads this table and decides what the decoding rules are before reading (and expanding) the compressed information itself.

Other Issues

The encoder's output file will usually be significantly shorter than the original input file. I say "usually" because there are two circumstances under which the output file could actually end up being longer than the input file.

If the four most common byte values are not drastically more common than all the others, then the output file will be longer than the input file. The "something else" values will be too frequent (an almost certain occurrence if the file being compressed is an executable binary program file. For highly technical reasons such files are nearly pseudo-random, with few outstandingly frequent unique byte values).

Also, the encoder's substitution table takes up a certain amount of space in the output file. If the input file were very short, the combination of frequency table and encoded data could be longer than the input data, even if that input data were otherwise compressible ASCII text.

The compressed file is extremely sensitive to error because with variable-length Huffman coding there no longer is a one-to-one relationship between bytes in the original data and bytes in the compressed file. The corruption of even a single data bit can wreck the file.

For example, consider the word "at," encoded as described above:

```
0001001xxxxxxxxxxxxxxxxxxxxxx
  a   t  remainder of text
```

If the fourth bit is "dropped" and thereby changed to zero, the decoder will not have "seen" the original "a." In fact, it will overrun the "t" because of the rule that says "if you see 0000, then take the next 4 bits as . . . "

The decoder is now hopelessly desynchronized with respect to the original input. It will, in fact, expand the remainder of the bit stream to gibberish.

For reasons of this nature, military and commercial communication and storage systems that employ data compression schemes invariably incorporate an error-correcting scheme to ensure integrity of the compressed data.

Interesting Reading

An excellent treatment of both Huffman codes and error correction is given in Richard Hamming's *Coding and Information Theory* (Prentice-Hall, 1980).

You should be aware that this marvelous book requires a good grounding in algebra and probability theory. The mathematics is unavoidable, but if you can cope with it, the book provides a valuable overview of information theory and its important major subtopics. Unlike most writers in the field of error correction, Hamming aspires to educate readers rather than to "snow" them. He succeeds, but you have to work with him—there is no "royal road." ◇

Microprocessors in Cars
(Continued from page 77)

kets a Voice Warning System that is based on National Semiconductor Corp.'s MM54104 Digitalker voice chip. Besides the chip, two 64K ROMs and a custom microprocessor are included. Most gauges and indicator lights may be attached to the system, which can monitor up to 14 functions, like seatbelt connections and engine temperature.

Chrysler got into speech synthesis in its 1983 top-of-the-line cars. It used Texas Instruments' TMS5110A voice-synthesis processor. The system spoke 11 messages. However, some of them, like, "Please fasten your seatbelts. Thank you." proved to annoy the occupant. This year's model has a switch that will disconnect the voice system and send the messages to the driver through tones and visual prompts.

Though satellite navigation may be a bit futuristic, more down-to-earth efforts are taking shape. Honda has an internal navigation system that consists of a 6" CRT, a 16-bit microprocessor, an eight-pole magnetic rotary Hall-effect IC pickup mileage sensor, and a gas-rate gyro sensor.

The mileage sensor emits electric signals via a pulsing system that functions according to tire revolutions.

The gas-rate gyro sensor is composed of a piezo-vibrator pump for circulating helium gas, a nozzle for injection of uniform helium gas, and two hot wires for sensing any deviation of injected gas flow.

When the car is moving straight ahead, helium gas hits both hot wires uniformly, keeping them at the same temperature. When the car turns, the gas flows differently, producing a temperature difference, which is reflected as a change in power output.

The microprocessor thus calculates the car's present location and displays the traveled course, present location, and forward direction of the car on the CRT, which is used with map overlays.

The Europeans have done something similar at Volkswagen with semiconductor manufacturer Siemens' Autoscout system. This system, which is now undergoing trials, uses both on-board devices and roadside sensors and transmitters.

In the basic system, a driver keys into a dashboard-mounted, microprocessor-based system the present position and destination coordinates as obtained from a map. A magnetic-field sensor in the car registers the angle between the vehicle's logitudinal axis and the earth's magnetic field.

Using this coordinate data, angle information, and distance pulses from the speedometer,the system continuously figures out and displays the destination on the dashboard's LCD. The direction is indicated by an arrow on a compass-like LCD. The particular road to take to reach the destination is left to the driver.

In the more advanced guidance mode, the system tells the driver the best way to reach the destination. For this, the system relies on infrared (IR) transmitters installed on traffic lights at major intersections. These IR beacons continuously spill out a stream of data pertaining to all major roads in a certain part of the city or rural area. When the car approaches a beacon, an IR receiver on the windshield picks up the data and feeds it to the dashboard system. The latter picks out and processes only that part of the data that it needs to guide the driver to the destination. ◇

PERSONAL ROBOTS CHARACTERISTICS AND SOURCES

TURTLES

Fred: This advanced turtle talks, moves and draws under LOGO or manual control. $400.
Androbot, Inc.
101 E. Daggett Dr.
San Jose, CA 95134
408-262-8676

Zeaker: A medium-function device, the Zeaker can be controlled through the printer port of most computers and is supplied with "learning algorithm" software. $300.
D&M Computing, Inc.
PO Box 2102
Fargo, ND 58102

Memocon Crawler: Computer or manually controlled, the Crawler is a nongraphics turtle in kit form. $79.95
Stock Model Parts
54 S. Denton Ave.
New Hyde Park, NY 11040
516-328-0200

Armadillo: A lower-function teaching tool, it has touch sensors and graphics ability. Kit $195, assembled $350.
Feedback, Inc.
620 Springfield Ave.
Berkeley Heights, NJ 07922
201-464-5181

Tasman and Tot: A two-member family of turtles that spans a low to high level of functions. Both devices feature LOGO-oriented graphics capabilities. Tasman $1250, Tot $250.
Harvard Associates
260 Beacon St.
Somerville, MA 02143
617-492-0660

Scorpian: Looks and in many ways functions like both a turtle and a true mobile robot. The Scorpian contains its own 6502-based microcomputer and is available in kit form only, without graphics capabilities. $660.
Sandhu Machine Design
3402 N. Mattis Ave.
Champaign, IL 61320
217-352-8485

Itsa-Box: Similar to the Scorpian in that it falls between a turtle and a mobile, the "Box" contains its own computer but does not provide graphics output. It does contain a simple vision circuit, however. (Prototype form at press time.) $400.
Technical Micro Systems, Inc.
366 Cloverdale St.
Ann Arbor, MI 41805
313-994-0784

ARMS

Robot I: This is an automated version of the Radio Shack/Tandy Armatron suitable for use with the TRS-80 Color Computer (including "learn mode").
Analog Micro Systems
5660 Valmont Rd.
Boulder, CO 80301
303-444-6809

Armdroid I: The "Droid" exists as a

fully functional manipulator available assembled or in kit. Controlled via a connection into the parallel (printer) port of most computers, the unit also offers a manual override option. $1295.

D&M Computing, Inc.
PO Box 2102
Fargo, ND 58102
701-235-7743

Armatrol, Armborg, Armdraulic, Armover, Armsort: This large family of manipulator arms covers the spectrum of electronic and electro-hydraulic technologies. All are controlled by an outboard computer or manually. Most are available with an educational/training package. Armatrol $1437, Armborg $3202, Armdraulic: single acting $6750, double acting $8250, Armover $2404, Armsort $1995.

Feedback, Inc.
620 Springfield Ave.
Berkeley Heights, NJ 07922
201-464-5181

Alpha I/II, Mini-Mover, Teach-Mover: The Microbot line is another broad family of manipulators. All offer automated or manual operation. The Alpha series contain their own microcomputers. Alpha I/II $8500/$13,900; Mini-Mover $1995; Teach-Mover $2795.

Microbot, Inc.
453 Ravendale Dr.
Mountain View, CA 94043
415-968-8911

Armatron: A fascinating example of a mass-produced personal robot arm. Though strictly a manually controlled device (via mock electronic joysticks), the unit provides virtually all manipulator functions. $35.

Radio Shack Div.
Tandy Corp.
1500 One Tandy Center
Fort Worth, TX 76102
817-390-3700

Movemaster: Similar in appearance to the Mini-Mover, the Movemaster contains an internal programmable controller with more than 64K of RAM or ROM. The controller allows the unit to execute repeatedly a sequence of movements. It connects to any parallel or serial computer and is BASIC-compatible. $1995.

Robotex
111 E. Alton St.
Santa Ana, CA 92707
714-556-8679

Rhino: The Rhino is a chain-driven arm that connects to any computer equipped with a serial (RS-232) interface. Though relatively small, the Rhino can hoist a respectable 5 lb. $3000.

Sandhu Machine Design
3402 N. Mattis Ave.
Champaign, IL 61320
217-352-8485

Robot IV: The IV, a base-mounted educationally oriented arm, has limited lift capability (1 oz). Suited for use with Commodore VIC-20 or 64 computers, the unit responds to BASIC program commands. $350.

Spectron Instrument Corp.
1342 W. Cedar Ave.
Denver, CO 80223
303-623-8987

MOBILE ROBOTS

Topo, BOB: Darlings of the press, and

Robots
(Continued from page 89)

the first announced products of Androbot, the Topo and (soon to be delivered) BOB are anthropomorphic robots that roll, talk and navigate. Topo requires an outboard computer; BOB has its "brains on board." Topo $1595, BOB $2500 plus.

Androbot, Inc.
101 E. Daggett Dr.
San Jose, CA 95134
408-262-8676

HERO 1, HERO JR: HERO 1 is a fully functional robot with all electronic senses, an internal 8-bit microcomputer, and manipulator. JR is a simplified version of its dad. HERO 1 $1250 kit, $2500 assembled; HERO JR kit $649.95, assembled $999.95.

Heath Co.
Benton Harbor, MI 49022
616-982-3200

Hubot: Hubot is a 4′ robot on wheels. It can play games, navigate, and follow pre-programmed paths. $3495.

Hubotics, Inc.
53758 Avenida Encinas
Carlsbad, CA 92008
619-438-9028

Maxx Steele: Maxx represents a new generation of mass-produced, low-cost consumer products with a remarkable complement of features. These include speech, manipulation, mobility, and programmability. A "user port" on Maxx's chest serves as an expansion bus. $300.

Ideal Div., CBS Toys, Inc.
183 Madison Ave.
New York, NY 10016
212-683-7810

Marvin: Sinister in appearance (not unlike Klatuu of *The Day the Earth Stood Still*), Marvin is a remarkably functional machine with most senses, good mobility and manipulation capabilities. Its onboard computer is based on the popular S-100 bus. $6175.

Iowa Precision Robotics, Ltd.
908 10th St.
Milford, IO 51251
712-736-2600

RB 5X: Looking much like R2D2, the RB 5X is a full-function robot popular with experimentors. It contains its own microcomputer and can roll, navigate, and even vacuum the rugs. RB's only problem . . . it's parent company is caught up in a Chapter 11 bankruptcy workout. $2295.

RB Robot Corp.
18301 W. 10th Ave.
Suite 310
Golden, CO 80401
303-279-5525

Genus: Its 4.5′ stature will make Genus the king of the mobile robot world. Fully functioned, the device, to be available in early 1985, will also include a speech recognition circuit.

Robotics International Corp.
2335 E. High St.
Jackson, MI 49203
517-788-6840

Hardware
(Continued from page 12)

look real compared to the "unreality" of a conventional mountain created graphically.

What Mandelbrot did was develop a fractal algorithm that could create a large object from a number of small objects. The result is a very lifelike final monochrome image.

Fractals can be best understood by following the accompanying illustration to create a mountain.

A. First draw a (nonequilateral) triangle on a sheet of paper.

B. Locate the approximate center of each side of the triangle and displace each midpoint by a distance proportional to the length of that side by a random displacement angle.

C. Connect the new point to the ends of its corresponding line, to form a small triangle at each side of the original triangle. Interconnect the three new apexes and join them to the old ones, which creates four new triangles.

D. Go back to step B and repeat the process on each new triangle as long as desired. After just a couple of steps, a (very) rough mountain is starting to form from the original triangle. However, as good as the final product appears, it will look like a two-dimensional image. It needs something more.

Another major difference between computer graphics and real life is color and shading—the interplay of light on the various (fractal) surfaces of the image being viewed. Obviously, there is also an algorithm for shading.

Simply stated, the algorithm is based on the fact that the reflection of light from any surface can be modeled by Lambert's cosine law, which states that the intensity of the reflected light varies as the cosine of the angle between the direction of the light source and a vector perpendicular to the surface (surface normal). The brightest reflection appears when the source is at the normal. Obviously, the interaction of the color of the impinging light and the color reflectivity of the surface also plays a role in the shading.

Since a fractal mountain will have a considerable number of tiny areas, all having different angles to the Sun, the shading can get quite complex. If various colors are used, the results can appear three-dimensional and lifelike. ◇

Taxan
(Continued from page 38)

may not have an audio input. In this case, you would need support from your stereo equipment to produce the audio.

If you have a computer that has only a TV output, plug that cable into the tuner antenna connector, and the tuner will now allow you to use a video monitor for a much better picture. Nice feature!

Performance

I connected My Tuner to a BMC 13″ medium-resolution composite monitor. The difference between the picture on a new 19″ color TV and the My Tuner/BMC combination was startling. Using the same antenna, I received some fringe stations clearly with My Tuner. One uhf station that was scarcely viewable on the TV was perfectly clear using the tuner.

Pictures that were good on the TV were great on the tuner/monitor combo. One frequently watched channel that normally comes in poorly—both picture and sound—was almost perfect with the tuner, including the sound. I can only conclude that My Tuner has exceptional signal sensitivity.

The tuner selector slides easily and "locks" on all but the weakest channels. The TUNER/COMPUTER switch eliminates cable swapping when you want to watch TV instead of computing. The tuner's rubber feet allow it to sit securely on top of the monitor.

Summary

Except for the lack of a telescoping built-in whip antenna, a 300-ohm antenna input, and some cable adapters, I found My Tuner 305 to be outstanding in design, appearance and performance. It can transform your infrequently used color monitor into the best color TV set you own! ◇

Cadplan
(Continued from page 42)

Earlier, I suggested that CAD systems were analogous to word processors in that they allowed the user to create and then edit or manipulate images. Indeed, Cadplan has facilities that would not seem out of place in a word processing program: MOVE, COPY, EDIT, FIND and DELETE.

Zoom and Pan Options

When editing a document with a typical text processor, it is easy to scroll to any specific word, sentence or paragraph. However, since Cadplan drawings are not sectioned off in pages, it uses a different approach to moving from place to place. Fairly small drawings will fit within the confines of the display. Typical drawings are too large for the display. To cope with this problem, Cadplan provides ZOOM and PAN commands, which when used in combination allow you to roam wherever you please on a drawing.

ZOOM, as the name suggests, gives the impresssion that you're moving closer to or farther away from a drawing. The closer you get (zooming in), the greater the detail you see. The farther away you get (zooming out), the greater the area that can be viewed, but the less detail you see.

The ZOOM feature is impressive. You can zoom out to a point where very nearly all of the drawing layer can be viewed, if only in superficial detail. Or you can zoom in to view an area of the drawing only a few units (inches, millimeters, or thousandths of an inch) across.

Cadplan has been designed to take advantage of the pixel resolution of a display so that the better the resolution, the finer the detail that can be represented. The IBM 640 × 200 RGB monitor coped fairly well with some test drawings that I created. Not surprisingly, text labels tended to lose their shape much more quickly than clear-cut geometric shapes when I zoomed out from a drawing.

Having decided how near or far you want to be from a drawing with ZOOM, the PAN command allows you to move or scroll the image in any direction. It's a little bit like being in a helicopter hovering over a building site—if you want to look at the garage, you move toward it. If you want to look at the roof of the building, you move over in that direction. Keeping the helicopter analogy in mind helps you understand how the ZOOM and PAN commands can interact.

Cadplan Symbols

Once you've drawn a detailed object, such as a kitchen appliance or a bathroom fixture, you can save the image of

Cadplan
(Continued from page 91)

that object to disk as a named Cadplan symbol for later recall.

A symbol is simply the Cadplan representation of an object—its shape, its color, the layer it occupies and its name. An object is saved as a symbol with the COPY or SYMbol commands from the main menu. Whole libraries of often-used symbols can be created for use in design projects.

For this review, I created a simple blueprint of a lot that included a three-bedroom main house, a guest house and a swimming pool. When there was more than one example of a bathroom fixture, each instance of the fixture (the bath, the sink, the toilet) was exactly the same. This is because each item was drawn only once, copied to disk as a named symbol, and then recalled and placed at its new location.

This symbol placement was easy to work with, but you can run into some difficulties it you don't remember a couple of points. In addition to giving a symbol a name when you save it, you must tell Cadplan what point on the object will be used as its reference point. This reference tells Cadplan where to place the object, relative to the mouse-controlled cursor, when you recall it. Say you save a picture of a teapot as a symbol. The most sensible reference point on the teapot might be the handle; clearly you move a teapot around by the handle. It will be easy to remember long after the symbol was saved.

If you don't use easily remembered reference points, your symbols might not appear where you would expect them to when you recalled them from disk. Of course, you can use the MOVE command to reposition the symbol, but that consumes time.

Also, always be sure that you're working on the correct database layer when you place a symbol. Otherwise, you could end up with your electrical wiring on one level and the main fuse box on another.

Database Extraction

With database extraction, information you need to include can be tagged to a whole drawing or just a single symbol within the drawing. There are two types of files used by Cadplan for this purpose: the attribute file listing the details of a complete drawing or symbol and the command file, which is a program file created by the user to carry out calculations.

The attribute file is an ASCII text file that can be created within Cadplan or with an ASCII word processor, such as WordStar. If you use keywords in this file, Cadplan can later use the data to list textual information or to carry out price or measurement calculations.

An attribute file follows the format:

```
**VENDOR**
The vendor
Information goes here
**COST**
Cost info
**PARTNUMBER**
Partnumber info
//
```

The words within double asterisks are look-up keywords, and the numerical data that follows a keyword can be used by the Cadplan command file for calculations. The double slash marks indicate the end of a page.

The command file has a variety of programming and output formatting statements. You can add up the length of all straight lines in a given area; arrange for keyboard input to be entered at a specific point; and compute areas.

Output

Obviously, it's no use spending a lot of time creating complex graphic images unless you have some way to print them out. Cadplan has a range of printer and plotter device drivers (with the emphasis on plotters). Out of 12 devices listed, the only dot matrix printer is the Epson FX-80. The other devices are plotters from IBM, Houston Instruments, Calcomp and Hewlett-Packard. Thanks to Hewlett-Packard, I was able to test the program with a six-pen HP 7475A plotter.

Cadplan's plotting routine is fairly simple to follow, even though it always alarms you with the message "File should be saved before continuing! Hit A to abort PLOT, or any key," whether or not you have already saved the file.

The trouble with printing out a graphics image is that Cadplan cannot always know how big your drawing will be and what size paper you will want to reproduce it on. The PLOT command allows the user to choose from a range of scales, as follows:

```
ANY
PNTR
PLTR
1/1
1/2
1/4
1/8
1/16
1/32
1/64
STRT
```

The $^1/_1$ option will reproduce each foot on the drawing as 1" on the plotter. However, if you wanted to include more of the drawing, you would probably select the $^1/_8$ option since it would reproduce each foot as $^1/_8$" on the plotter.

During this review, I tried plotting at most of the scales. The only time I encountered a problem was with the $^1/_1$ option. For some reason Cadplan kept overwriting the correct image with data from outside the selected area.

You have to be very careful to choose the right drawing scale and line width. Otherwise, you will end up with lines that don't meet or thick lines that are only shaded in the horizontal and vertical directions—angled or curved lines will not be shaded.

A drawback of using an IBM PC with only one serial port is that you have to share the port between the mouse and the plotter—switching cables whenever Cadplan tells you to. This can be a real annoyance. My guess is that most professionals who use Cadplan will probably want to use it on an IBM PC/XT because of the increased speed and the extra space provided by the 10M-byte

hard drive. If this is the case, adding an extra serial port is a minimal additional expenditure, one I would definitely recommend.

Often, the drawing you've created will not fit onto one sheet of paper, so Cadplan allows you to section the image into an even number of sheets. A special view box is used to section the drawing or to select only one small area of a drawing for enlargement.

Conclusions

Other than the output error mentioned earlier, I encountered no serious problems with Cadplan. It seemed robust and never dumped me back out to DOS. Thankfully, since many mouse button clicks are necessary, Cadplan's designers were sensible enough to choose an acceptable audio feedback sound to indicate that a button had been depressed,

The documentation was not so sensible. After an initial 10 minutes with Cadplan, I was able to find my way around the system, only occasionally bumping into unforeseen obstacles. Reading the documentation usually helped, but barely. I was surprised at its mediocre quality. It's produced in "copy-of-a-copy" quality and can be difficult to follow. It would benefit from some reorganization and an index. There are also many spelling mistakes.

Clearly, you cannot use Cadplan to do everything you might with a pencil and paper, but the product's designers have focused its powers quite well. Cadplan doesn't seem to have any oddball features that will be used once and then forgotten; nothing has been included just for fun. ◇

Editor's Note: As this review went to press, Personal CAD Systems announced a new release of Cadplan. The new version, release 1.4, supports high-resoluiton cards, including those from Scion, Sigma, Hercules, and Conographics. The new release lets the user scale items (a 2" circle scaled by a factor of 0.5 becomes a 1" circle); it displays a line's length and angle in units the user specifies (meters, mils, etc.) while drawing it; it adds cross hatching; it lets the user zoom in or out while the draw function remains active; and it can automatically insert doors and windows. Included with the new release is a hardware security device that plugs into an RS-232 port and can be connected to a mouse or a digitizer. The menu structure has changed somewhat, with the intent of improving ease of use. Other basic capabilities remain the same.

1984 EDITORIAL INDEX

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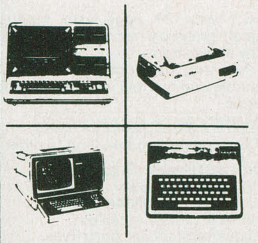

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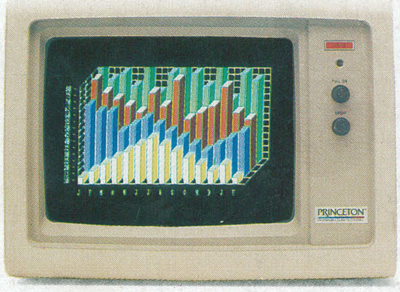
HX-12. A high resolution monitor at a medium resolution price.



HX-12 is a high resolution RGB color monitor that's colorful enough for all your graphics needs and sharp enough for word processing.

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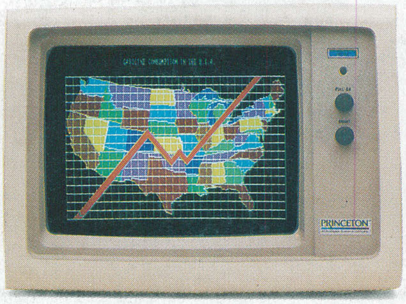
The SR-12 delivers even better resolution color for a better-than-ever price.



At first glance, the SR-12 might appear similar to the HX-12 with a non-glare screen and .31mm dot pitch supporting 690 horizontal resolution. But take a closer look. SR-12's scan frequency is 31.5 KHz, allowing the SR-12 to support 480 vertical resolution in non-interlaced mode. That means a high-quality, flickerless image with text that's up to monochrome standards. What's more, you get all that quality for **$799.**

For full compatibility with all IBM software, get the **Princeton Scan Doubler**. Priced at **$249,** it allows you to run the SR-12 from a standard IBM or IBM equivalent color card in the IBM PC.

You can't beat the SR-12 for resolution or price.

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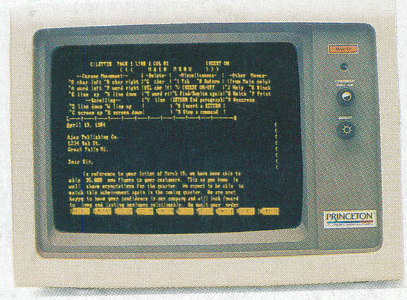

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